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SERIALS

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- Akademiya Nauk SSSR, *Izvestiya*, Geophysics Series, in English translation (American Geophysical Union). New York.
- Alabama, Geological Survey, Annual Reports. University.
- Alaska, Division of Mines and Minerals, Report. [Juneau].
- American Ceramic Society, *Journal*. Easton, Pennsylvania.
- American Journal of Science. New Haven, Connecticut.
- American Journal of Science, Radiocarbon Supplement. New Haven, Connecticut.
- American Mineralogist (Mineralogical Society of America). Ann Arbor, Michigan.
- Arizona Highways. Phoenix.
- Cahiers de Géographie de Québec (Université Laval, Institut de Géographie). Quebec.
- California, University, Radiation Laboratory, [Publication]. Livermore.
- Canada, Geological Survey, Bulletin; Geophysics Paper; Information Circular; Paper. Ottawa.
- Canada, Mineral Resources Division, Mineral Information Bulletin. Ottawa.
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- Focus (American Geographical Society). New York.
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- Geographical Review (American Geographical Society). New York.
- Geophysics (Society of Exploration Geophysicists). Tulsa, Oklahoma.
- Georgia Academy of Science, Bulletin. Atlanta.
- Georgia, Dept. of Mines, Mining and Geology, Information Circular. Atlanta.
- Harvard University, Museum of Comparative Zoology, Bulletin. Cambridge, Massachusetts.
- Houston Geological Society, Bulletin. Houston, Texas.
- Illinois State Academy of Science, Transactions. Springfield.
- Illinois State Geological Survey, Circular; Report of Investigations. Urbana.
- Illinois State Water Survey, Circular. Urbana.
- International Geology Review (American Geological Institute). Washington, D.C.
- Kansas, University, Science Bulletin. Lawrence.
- Kansas, University, Museum of Natural History, Publications. Lawrence.
- Minnesota Academy of Science, Proceedings. [Minneapolis].
- National Parks Magazine. Washington, D.C.
- New Jersey, Dept. of Conservation and Economic Development, Division of Water Policy and Supply, Water Resources Circular. Trenton.
- New Mexico, State Engineer Office, Technical Report. Santa Fe.
- New York Academy of Sciences, Transactions. New York.
- New York (State), Water Power and Control Commission, Bulletin. Albany.
- North Carolina, Dept. of Conservation and Development, Division of Mineral Resources, Bulletin. Raleigh.
- North Dakota Geological Survey, Miscellaneous Map; Report of Investigations. Grand Forks.
- Northwest Science (Northwest Scientific Association). Cheney, Washington.
- Northwestern University, Dept. of Geography, Studies in Geography. Evanston, Illinois.
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- Ohio Journal of Science. Columbus.
- Ohio State University, Engineering Experiment Station, Bulletin. Columbus.
- Ontario, Dept. of Mines, Annual Report. Toronto.
- Plateau (Northern Arizona Society of Science and Art, Inc.). Flagstaff, Arizona.
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- Shell News (Shell Oil Company). New York.
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- U.S. Snow, Ice and Permafrost Research Establishment, Research Report; Technical Report. Wilmette, Illinois.
- U.S. Waterways Experiment Station, Vicksburg, Miss., Miscellaneous Paper; Technical Report.
- Utah, University, Engineering Experiment Station, Bulletin. Salt Lake City.
- Water Well Journal. Urbana, Illinois.
- World Oil. Houston, Texas.

PURCHASE OF PUBLICATIONS

Those wishing to purchase items abstracted herein should address their orders to the agency, society, or organization indicated in the bibliographic citations preceding the abstracts, or to their local book dealer. The city and state for the serials cited are given above. The American Geological Institute, publisher of *GeoScience Abstracts*, regrets that it cannot fill purchase orders for abstracted publications other than its own.

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

923. Canada, Geological Survey. ALMA, CUMBERLAND-WESTMORLAND AND ALBERT COUNTIES, NOVA SCOTIA-NEW BRUNSWICK: Its: Geophysics Paper 802, aeromagnetic map, contour intervals 10, 20, 100, and 500 gammas, scale 1:63,360, lat. 45°30'-45°45'N., long. 64°30'-65°W., 1960.
924. Canada, Geological Survey. AMHERST, WESTMORLAND AND CUMBERLAND COUNTIES, NOVA SCOTIA-NEW BRUNSWICK: Its: Geophysics Paper 797, aeromagnetic map, contour intervals 10, 100, and 500 gammas, scale 1:63,360, lat. 45°-46°N., long. 64°-64°30'W., 1960.
925. Canada, Geological Survey. BERWICK, WESTMORLAND AND ANNAPOLIS COUNTIES, NOVA SCOTIA: Its: Geophysics Paper 800, aeromagnetic map, contour intervals 10, 20, 100, and 500 gammas, scale 1:63,360, lat. 45°-45°15'N., long. 64°30'-65°W., 1960.
926. Canada, Geological Survey. CAPE CHIGNECTO, CUMBERLAND COUNTY, NOVA SCOTIA: Its: Geophysics Paper 801, aeromagnetic map, contour intervals 10, 20, 100, and 500 gammas, scale 1:63,360, lat. 45°15'-45°30'N., long. 64°30'-65°W., 1960.
927. Canada, Geological Survey. GASPÉ, KINGS, ANNAPOLIS AND LUNenburg COUNTIES, NOVA SCOTIA: Its: Geophysics Paper 798, aeromagnetic map, contour intervals 10, 20, 100, and 500 gammas, scale 1:63,360, lat. 44°45'N., long. 64°30'-65°W., 1960.
928. Canada, Geological Survey. HALIFAX, HALIFAX COUNTY, NOVA SCOTIA: Its: Geophysics Paper 789, aeromagnetic map, contour intervals 10, 20, 100, and 500 gammas, scale 1:63,360, lat. 44°30'-44°45'N., long. 63°30'-64°W., 1960.
929. Canada, Geological Survey. NEW GOWER, LUNenburg, ANNAPOLIS, KINGS AND WESTMORLAND COUNTIES, NOVA SCOTIA: Its: Geophysics Paper 798, aeromagnetic map, contour intervals 10, 20, 100, and 500 gammas, scale 1:63,360, lat. 44°30'-44°45'N., long. 64°30'-65°W., 1960.
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931. Canada, Geological Survey. PARRSBOURGH, CUMBERLAND, COLCHESTER AND KINGS COUNTIES, NOVA SCOTIA: Its: Geophysics Paper 795, aeromagnetic map, contour intervals 10, 20, 100, and 500 gammas, scale 1:63,360, lat. 45°15'-45°30'N., long. 64°-64°30'W., 1960.
932. Canada, Geological Survey. SAMBRO, HALIFAX COUNTY, NOVA SCOTIA: Its: Geophysics Paper 774, aeromagnetic map, contour intervals 10, 20, 100, and 500 gammas, scale 1:63,360, lat. 44°15'-44°30'N., long. 63°30'-64°W., 1960.
- 2-1933. Canada, Geological Survey. SPRINGHILL, CUMBERLAND AND COLCHESTER COUNTIES, NOVA SCOTIA: Its: Geophysics Paper 796, aeromagnetic map, contour intervals 10, 20, 100, and 500 gammas, scale 1:63,360, lat. 45°30'-45°45'N., long. 64°-64°30'W., 1960.
- 2-1934. Canada, Geological Survey. WOLFVILLE, KINGS AND HANTS COUNTIES, NOVA SCOTIA: Its: Geophysics Paper 794, aeromagnetic map, contour intervals 10, 20, 100, and 500 gammas, scale 1:63,360, lat. 45°-45°15'N., long. 64°-64°30'W., 1960.
- 2-1935. Grantz, Arthur. GENERALIZED GEOLOGIC MAP OF THE NELCHINA AREA, ALASKA, SHOWING IGNEOUS ROCKS AND LARGER FAULTS: U.S. Geol. Survey, Misc. Inv. Map I-312, scale 1:96,000, lat. approx. 61°45'-62°19'20"N., long. approx. 147°-148°08'W., 1960.
- 2-1936. Grantz, Arthur. GEOLOGIC MAP OF TALKEETNA MOUNTAINS (A-1) QUADRANGLE, AND THE SOUTH THIRD OF TALKEETNA MOUNTAINS (B-1) QUADRANGLE, ALASKA: U.S. Geol. Survey Misc. Inv. Map I-314, scale 1:48,000, lat. 62°-62°20'N., long. 147°-147°30'W., 1960.
- 2-1937. Grantz, Arthur. GEOLOGIC MAP OF TALKEETNA MOUNTAINS (A-2) QUADRANGLE, ALASKA, AND THE CONTIGUOUS AREA TO THE NORTH AND NORTHWEST: U.S. Geol. Survey, Misc. Inv. Map I-313, scale 1:48,000, lat. 62°-62°20', long. 147°30'-148°20'W., 1960.
- 2-1938. Dibblee, Thomas W., Jr. PRELIMINARY GEOLOGIC MAP OF THE APPLE VALLEY QUADRANGLE, CALIFORNIA: U.S. Geol. Survey, Mineral Inv. Map MF-232, scale 1:62,500, lat. 34°30'-34°45'N., long. 117°-117°15'W., 1960.
- 2-1939. Dibblee, Thomas W., Jr. PRELIMINARY GEOLOGIC MAP OF THE VICTORVILLE QUADRANGLE, CALIFORNIA: U.S. Geol. Survey, Mineral Inv. Map MF-229, scale 1:62,500, lat. 34°30'-34°45'N., long. 117°15'-117°30'W., 1960.
- 2-1940. GEOLOGIC AND STRUCTURE MAP, MESA COUNTY, COLORADO, AND VICINITY. Prepared and published by Raymond C. Robeck (535 Orchard Avenue, Grand Junction, Colorado): scale approx. 1 in. to 1 1/3 mi., 1960.

Map shows geologic contact between all formations, axes of major anticlines and synclines, location of all wells drilled and classifications. Structure contours of 500 ft. are on top of the Dakota. Major planimetric items are included.--Courtesy Worldwide Oil & Gas Abstracts, v. 5, no. 3, p. 24, May-June 1960.
- 2-1941. Kottlowski, Frank E. GEOLOGY AND COAL DEPOSITS OF THE SWITZ CITY QUADRANGLE, GREENE COUNTY, INDIANA: U.S. Geol. Survey, Coal Inv. Map C-41, scale 1:24,000, con-

tour interval 10 ft., lat. 39° - $39^{\circ}07'30''$ N., long. 87° - $87^{\circ}07'30''$ W., 1960.

The map covers 58 sq. mi. in southwestern Indiana and shows the mined areas of 4 principal coal beds and the structure, extent, and distribution of bedrock and unconsolidated surficial deposits. Tables give thickness and attitude of beds at key points, coal reserves by individual beds, and oil and gas test-hole data. A correlation chart and graphic sections show the sequence of underlying rocks and typical underground relations. A brief text is included.--U.S. Geol. Survey.

2-1942. Anderson, Sidney B., and Herbert A. Mendoza. **CONTOUR MAP OF THE PRE-MESOZOIC SURFACE IN NORTH DAKOTA**: North Dakota Geol. Survey, Misc. Map no. 6, scale 1:1,000,000, contour interval 100 ft., Jan. 1960.

2-1943. Anderson, Sidney B., and Herbert A. Mendoza. **PRE-MESOZOIC PALEOGEOLOGIC MAP OF NORTH DAKOTA**: North Dakota Geol. Survey, Misc. Map no. 7, scale 1:1,000,000, Jan. 1960.

2-1944. Hansen, Miller. **REGIONAL GRAVITY MAP OF NORTHWESTERN NORTH DAKOTA**: North Dakota Geol. Survey, Rept. Inv. no. 35, 1 sheet, scale 1/2 in. to 1 mi., contour interval 1 milligal, Feb. 1960, 2 refs.

Bouguer gravities were plotted from field observations with an average station density of 2 per sq. mi. Elevations were obtained from 20 U.S. Geological Survey 7 1/2-min. topographic maps in Divide County and adjacent areas in Burke and Williams counties. Observations were made during the 1959 field season with a Carter type Y gravity meter calibrated at .71 gravity units per dial division. The map ties in with the Regional Gravity Map of South Saskatchewan published by the Dept. of Mineral Resources, Province of Saskatchewan.--Auth.

2-1945. **OIL AND GAS MAP OF EASTERN UTAH**. Compiled by Western States Map Company (343 South State Street, Suite 216, Salt Lake City, Utah): Map U-38, scale approx. 1 in. to 4 mi., lat. 37° - 41° N., long. 109° - 112° W., 1960.

2-1946. **OIL AND GAS MAP OF WESTERN UTAH**. Compiled by Western States Map Company (343 South State Street, Suite 216, Salt Lake City, Utah): Map U-37, scale approx. 1 in. to 4 mi., lat. 37° - 41° N., long. 112° - 114° W., 1960.

2-1947. **STRUCTURE MAP OF HARLEY ANTICLINE, GRAND COUNTY, UTAH**. Prepared and published by Raymond C. Robeck (535 Orchard Avenue, Grand Junction, Colorado): scale 1 in. to 1,000 ft., contour interval 100 ft., 1960.

Contour intervals and elevations are given from the top of the Dakota sandstone (Upper Cretaceous). Oil and gas wells, shows, and dry holes are indicated.

2-1948. **GEOLOGIC AND STRUCTURE MAP, LISBON VALLEY, UTAH-COLORADO, AND VICINITY, SHOWING OIL AND GAS WELLS IN RELATION TO URANIUM DEPOSITS**. Prepared and published by Raymond C. Robeck (535 Orchard Avenue, Grand

Junction, Colorado): scale approx. 1 in. to 3 mi., [1960].

Map shows pre-Morrison, Morrison (Jurassic), and post-Morrison formations. Faults, V-U ("carbonate") deposits and Cu and Cu-Ag mines are indicated. Oil and gas wells, shows, and dry holes are plotted.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Stratigraphy 2-1996; Geohydrology 2-2123, 2-2124, 2-2128.

2-1949. U.S. Air Force, Cambridge Research Center, Geophysics Research Directorate. **PROCEEDINGS OF THE SECOND ANNUAL ARCTIC PLANNING SESSION, OCTOBER 1959**. Edited by Vivian C. Bushnell: Its: GRD Research Notes, no. 29, 172 p., illus., maps, diags., graphs, tables, Dec. 1959, refs.

Results of field investigations and laboratory studies associated with the Arctic Terrain Research Program of the Terrestrial Sciences Laboratory are given. The papers included are those presented at the Second Annual Arctic Planning Session sponsored by the Terrestrial Sciences Laboratory. Reports include research accomplished in the Arctic Ocean, studies of ice-free land, studies of the Ellesmere ice shelf, investigations of arctic lakes, research into the physical and engineering properties of ice, and related topics.--Auth.

Scientific papers are as follows:

ARCTIC OCEAN RESEARCH

Arctic Ocean Research, by Irene M. Cotell, p. 10
Some Features of Arctic Deep-Sea Sedimentation, by Kenneth Hunkins, p. 11-15.

Oceanographic and Geophysical Investigations at Arctic Drifting Station Charlie, by William J. Cromie, p. 16-21.

Geophysical Investigations at Fletcher's Ice Island, T-3, by G. V. Keller and Donald Plouff, p. 22-25.

Studies of Micrometeorology at Fletcher's Ice Island, T-3, by Peter Larsson, p. 26-31.

Oceanographic Observations at Fletcher's Ice Island, T-3, by Kuo Kusunoki, p. 32-38.

Build-Up of Thick Floating Ice in Arctic Areas, by A. P. Crary, p. 39-42.

Future Plans for Oceanographic and Glaciological Studies at T-3, by Ukichiro Nakaya, p. 43-44.

ICE-FREE LAND PROGRAM

Ice-Free Land Program, by Stanley M. Needleman, p. 46-50.

Geologic Investigations, by William E. Davies, p. 51-54.

Engineering Aspects and Soils Investigations, by Donald W. Klick, p. 55-60.

Groundhog 1959 - East Greenland, by Joseph H. Hartshorn, p. 61-67.

Investigations in the Storelv Area, East Greenland, by George E. Stoertz, p. 68-76.

ELLESMERE ICE SHELF PROGRAM

Ellesmere Ice Shelf Investigations, by Daniel G. Anderson, p. 78-86.

Ellesmere Island Ice Shelf Meteorologic Program by James R. Lotz, p. 87-91.

IC LAKES AND ALASKAN COASTAL STUDIES
 e Mount Chamberlin-Barter Island Project, 1959
 ram and Operations, by G. William Holmes, p.

imatic Observations During Spring and Early
 er 1959, Lake Peters, Alaska, by Carroll Rock,
 -97.

ermal Studies on Lakes Peters and Schrader,
 a, by John E. Hobbie, p. 98-101

eliminary Report on Lake Peters, Alaska, Ice
 es, by David F. Barnes, p. 102-110.

eliminary Progress Report, Arctic Coast Geo-
 al Investigations 1959, by C.R. Lewis, p. 111-

ICAL AND ENGINEERING PROPERTIES OF ICE
 yysical and Engineering Properties of Ice, by C.
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 by J.B. Lyons and R.E. Stoiber, p. 141-151.

eam Protection and Preservation of Arctic Ice
 rips, by Cornelius S. Grove, Jr., and E.J.
 er, p. 152-153.

CELLANEOUS PAPERS

he C-130 as a Support Aircraft, by Thomas D.N.
 hit, p. 156-158.

he Whiteout Phenomenon, by Joseph M. Quash-
 , p. 159-162.

he Contraction Theory of Ice-Wedge Polygons,
 rthur H. Lachenbruch, p. 163.

reliminary Report on Thermoluminescence of
 estones from Thule, Greenland and Ward Hunt
 and on Ellesmere Ice Shelf, by Edward J. Zeller,
 64-165.

50. Meen, V.B. QUETICO GEOLOGY: 54 p.,
 , maps, diags., Toronto, University of Toronto
 s, 1959, 10 refs.

popular account of the geology of Quetico Pro-
 al Park, Ontario, Canada. All the rocks are
 ambrian, Couchiching through Keweenawan.
 stocene glaciation modified the topography. Fe
 Cu minerals are the only ores to have been found
 in the park.--M. Russell.

51. Pye, Edgar George. GEOLOGY OF THE
 ITOUWADGE AREA: Ontario, Dept. Mines,
 Rept., v. 66, pt. 8, 1957, 114 p., 23 illus.,
 s (col. geol. map in pocket, scale 1:31,680),
 , diags., 1960, refs.

ll consolidated rocks in the Manitowadge Lake
 (Thunder Bay district, N. shore of Lake Supe-
 are Precambrian. They make up 4 groups,
 ed Keewatin, pre-Algoman(?), Algoman, and
 eenawan to emphasize similarities to other simi-
 groups that have the same names and relative
 in other parts of the Canadian Shield. The old-

est formations of the Keewatin group are metavolcan-
 ics, succeeded stratigraphically upward by common
 metasediments, Fe formation, and an unusual garnet-
 amphibole-(biotite) schist. Basic igneous rocks,
 which cut the Keewatin formations, are considered
 to be pre-Algoman in age.

The Algoman is represented principally by large
 masses of granitic rocks, and also by small sills and
 dikes of microgranodiorite, pegmatite, aplite, and
 lamprophyre and associated basic eruptives. During
 this period the Keewatin and pre-Algoman(?) rocks
 were intensely metamorphosed, and in its closing
 stages the mineral deposits of the area were formed.
 The youngest consolidated rock exposed in the area
 is diabase, which occurs as sinuous dikes cutting
 sharply across all the other rock formations; this has
 been assigned to the Keweenawan as defined above
 and, because of its resemblance and proximity to the
 late Precambrian diabase intrusives exposed about
 the shore of Lake Superior, may actually be of Ke-
 weenawan age in the strict sense of the terminology.

Only one period of folding has been recognized.
 Primarily, the Archean volcanics and sediments were
 folded into structures of NE. plunge. This deforma-
 tion was followed by the formation, along the fold
 axes, of large masses of granitic rocks, by the in-
 trusion, as dikes and sill-like bodies, of micro-
 granodiorite, pegmatite, and lamprophyre, and by
 the development, in certain structurally favourable
 loci, of sulfide replacement deposits. At a later pe-
 riod the area was invaded by a swarm of N.-S. dia-
 base dikes. After this invasion, the various rock
 formations were dislocated by movements along
 E.-W., N.-S., NE.-, and NW.-striking faults.

Exploration work in the Manitowadge Lake area
 in 1953 and in 1954 resulted in the discovery of sev-
 eral ore bodies. These are primarily base metal
 deposits, the principal constituents being chalcopy-
 rite and sphalerite. They also contain Ag and some
 small amounts of Pb. Two occurrences are being
 mined profitably at present.--M. Russell.

2-1952. Archibald, G.M. PRELIMINARY REPORT
 ON THE SOUTHWEST QUARTER OF LEVY TOWN-
 SHIP, ELECTORAL DISTRICT OF ABITIBI-EAST:
 Quebec, Dept. Mines, Prelim. Rept. no. 419, 11 p.,
 fold. geol. map (Prelim. Map no. 1319), scale
 1:12,000, 1960, 2 refs.

The map-area (approx. $49^{\circ}44' - 49^{\circ}48' \text{N. } 74^{\circ}48' - 74^{\circ}55' \text{W.}$), covering 25 sq. mi., was mapped in 1958.
 The area is completely underlain by Precambrian
 rocks, covered in most places by a variable thick-
 ness of glacial debris. Keewatin-type volcanic rocks
 are the oldest and comprise metabasalt, metaandesite,
 metarhyolite and many interbeds of fine- to medium-
 grained pyroclastic material. The Keewatin-type
 rocks have a general northwesterly trend, and they
 have been invaded by many intrusive rocks varying
 in composition from diorite and granodiorite to
 peridotite and pyroxenite.

Although rocks of the Opemisca series of Tolman
 and Norman are not exposed in the present area, the
 terms pre-Opemisca and post-Opemisca are used
 for the purpose of clarity. The term pre-Opemisca
 is used for rocks older than those of the ultrabasic
 complex, and post-Opemisca is reserved for the
 ultrabasic complex and the more recent formations.
 --From auth., p. 1-2.

Five mining properties are described.

2-1953. Béland, Jacques, and Robert Bergeron.
 ESQUISSE GÉOLOGIQUE DU QUÉBEC MÉRIDIONAL

[GEOLOGIC SKETCH OF SOUTHERN QUEBEC]:
Cahiers de Géographie de Québec, v. 3, no. 6, p. 131-138, fold map, Apr.-Sept. 1959, 35 refs.; text in French.

A concise description of the main geological features. In the Laurentian highlands distinction is made between the Precambrian of the Timiskaming area and of the Grenville area. Stratigraphic correlation problems of the Grenville series are discussed. It is proposed to restrict this name to carbonate and noncalcareous metaclastic rocks, excluding the hornblende and plagioclase gneisses. Recent fieldwork shows the contact between the Timiskaming and Grenville areas locally to be by faults, at many other places however by a gradual transition.

The St. Lawrence lowlands are constituted by 8,000-9,000 ft. of Ordovician sediments gently folded into a large syncline. On its southeastern border the syncline is overthrust by the Appalachians. Two main orogenic phases, the Taconic phase at the end of the Ordovician and the Acadian at the end of the Devonian, gave rise to the Appalachian Highlands. The pre-Taconic zone shows a strong relief. It is formed by various rocks folded into a large anticlinorium and a narrow synclinorium. Preorogenic or synorogenic serpentinite intrusions are at the origin of the economically very important asbestos deposits.

The post-Taconic zone along the SE. of the Appalachians shows a subdued landscape. It consists of a strongly folded synclinorium of clastic sediments with some lava flows. Some granite intrusions occurred after the Acadian phase, possibly during the middle Devonian. Other, alkaline, intrusions took place much more recently between Montreal and the Appalachians, possibly during the Tertiary.--C. Voûte.

2-1954. Béland, René. RAWDON AREA, MONT-CALM AND JOLIETTE ELECTORAL DISTRICTS: Quebec, Dept. Mines, Geol. Rept. 92, 35 p., 14 illus. on 8 pls., geol. map (in pocket), scale 1:63,360, 1960, 10 refs.

The Rawdon area, mapped during 1948, covers 210 sq. mi. ($46^{\circ}00'-46^{\circ}15'N$. $73^{\circ}30'-73^{\circ}45'W$.). The oldest rocks are metasedimentary formations of the Grenville series. They consist of glassy metaquartzites, sillimanite-garnet paragneisses, and crystalline limestones containing diopside and serpentine.

In early Paleozoic time, well stratified sediments were laid down upon the crystalline gneisses. These Paleozoic formations are now exposed in the bed and banks of Ouareau river, near Saint-Liguori. The Paleozoic rocks have remained horizontal and undeformed, except for some normal faulting S. and SW. of the area. The great regional breaks surmised from topographic features within the Shield area may have formed at the same time. Except for this faulting and fracturing, no record is left of the geological history of the region from the Ordovician epoch to the Quaternary. The peneplained and dissected aspect of the Shield suggests prolonged denudation periodically modified by isostatic movements.

During the Quaternary the map-area was covered by the continental ice sheet. Retreat of the ice was accompanied by a marine invasion, and the clays and silts of the lowlands accumulated in the Champlain sea.

Sands and gravels are the only mineral resources now exploited. Some exploration work was carried out during 1948-1959. A study of the clay deposits of St. Julien area was made, and some prospecting,

geophysical work, and diamond drilling was done on occurrences of ilmenite and titaniferous magnetite.--A.C. Sangree.

2-1955. Bray, J. Guy. PRELIMINARY REPORT ON RAIMBAULT RIVER AREA, ROBERVAL ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 421, 8 p., fold. geol. map (Prelim. Map no. 1326), scale 1:63,360, 1960, ref.

The 250 sq. mi. map-area ($48^{\circ}15'-48^{\circ}35'N$. $72^{\circ}45'-73^{\circ}W$.), mapped in 1959, lies about 32 mi. WSW. of the town of Roberval. All the consolidated rocks of the area are Precambrian. Gneisses, with a general NW. to N. strike, underlie most of the area; bodies of metagabbro are found throughout the gneisses. Large plutons intrude these older rocks in the SW., SE., and N., and smaller intrusions occur elsewhere. The intrusive rocks consist chiefly of pyroxene-quartz monzonite. The associated pink granites are believed to be younger than, but genetically related to, the quartz monzonites. In several places, thin basic dikes or sills cut the earlier rocks.

Glacial striae, erratics, and crescentic gouges show that the last glaciers moved SSW. to SSE.--From auth., p. 2.

2-1956. Chown, E.H. PRELIMINARY REPORT ON THE PAPACHOUÉSATI RIVER AREA, MISTASSINI TERRITORY: Quebec, Dept. Mines, Prelim. Rept. no. 415, 9 p., fold. geol. map (Prelim. Map no. 1318), scale 1:63,360, 1960, 4 refs.

The 365 sq. mi. map-area ($51^{\circ}30'-51^{\circ}45'N$. $72^{\circ}30'-73^{\circ}$) lies 220 mi. N. of Lake St. Jean and 145 mi. NE. of Chibougamau. It was mapped in 1959. The consolidated rocks are all Precambrian. Exposures are poor except in the deeply incised valleys of the Papachouésati and Cheno rivers and in the mountainous parts. Steeply-dipping volcanic and sedimentary rocks, which have been metamorphosed to hornblende and biotite schists, form the oldest series. These rocks crop out in a broad belt in the northwestern part of the area and elsewhere as small scattered remnants. The remnants are included in a gneissic, granodiorite complex which is exposed in the hills in the central part of the area and in scattered outcrops to the E. Massive, pink, biotite granite, locally hornblende-bearing, intrudes the granodiorite complex in large masses as well as in small dikes and sills. One large mass is exposed in the hills along the northern edge of the area and a second is in the SE. corner in the beds of the Cheno and de la Traite rivers. The granite is intruded in turn by one irregular mass and by dikes of quartz-orthoclase porphyry. This rock is limited to a small area N. of the junction of the Holton and Papachouésati rivers.

These early Precambrian rocks are overlain unconformably by the Papaskwasati formation, the lowermost of the Mistassini group. From scattered exposures of the units of this formation, it is inferred that the formation underlies most of the drift covered southwestern and S.-central parts of the area. Three outliers N. of the main outcrop mass indicate that the formation was once much more extensive. Dikes of gabbro and associated porphyritic diabase cut the early Precambrian rocks.

Little prospecting has been done, but widespread occurrence of pyrite suggests that the area may have economic possibilities. Abundant supplies of sand and gravel occur.--From auth., p. 2-3, 8-9.

57. Clarke, P.J. PRELIMINARY REPORT
ORMANVILLE AREA, SAGUENAY ELECTORAL
DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no.
14 p., fold. geol. map (Prelim. Map no. 1317),
scale 1:63,360, 1960, 7 refs.

The 180 sq. mi. map-area ($52^{\circ}45' - 53^{\circ}00'N$, $67^{\circ}30'W$)
was mapped in 1959, lies about 260 mi. NNW. of
Montreal and directly N. of Mt. Wright. The area
within the Grenville subprovince, and all con-
tained rocks are Precambrian. They are believed
to be present, in part, the metamorphosed equivalents
of the sedimentary rocks of the Labrador trough.

In the S., the rock types include biotite schist,
gabbro and migmatite, biotite garnet schist, mus-
covite kyanite garnet schist, biotite schist with
gabbro, crystalline limestone, quartzite and
gabbro, muscovite schist, quartz specularite and
gabbro, magnetite ironstone and quartz-iron silicate-
biotite ironstone. These rocks have been injected
by generally conformable bodies of muscovite-biotite
gabbro and gabbro.

In the N., rocks probably equivalent to the biotite
gabbro and schists, quartz grunerite magnetite
gabbro, and gabbro have been metamorphosed to the
migmatite facies and injected and metasomatized by
hypersthene-bearing granite.

The structure of the gneisses and Fe-bearing
rocks is characterized by isoclinal and overturned
folds with NE.- or NW.-trending axes. The folds
in the rocks of the granulite facies in the northern
part of the area are equally tight but less complex.
The primary economic interest of the area lies
in the ironstone units widely exposed in the S. Of
several types of ironstone, the quartz-specularite
type is considered to have the best economic po-
tentialities. Its Fe content is variable but generally
ranges 25% to 35% over thicknesses of 30 to 300 ft.
In some places, such as S. of Mordridge Lake, its
thickness is increased by plastic flow or by repetition
of beds by folding. Some of this type is deeply
fractured and friable, permitting easy crushing for
concentration.

The magnetite-oxide ironstone facies carries about
the same amount of Fe as the specularite facies. It
is exposed at the nose of the Daigle Lake syncline
in the Bloom Lake syncline. In both these areas
the ironstone appears to have been thickened by
folding. --From auth. p. 2, 12.

58. Côté, P.E. CHERTSEY AREA, JOLIETTE,
MONTREAL AND TERREBONNE ELECTORAL DIS-
TRICTS: Quebec, Dept. Mines, Geol. Rept. 93, 30
p., 16 illus. on 8 pls., geol. map (in pocket), scale
1:63,360, 1960, 10 refs.

The Chertsey area, mapped during summer of
1959, is in the Laurentian region about 40 mi. NNW.
of Montreal. It is bounded by latitudes $46^{\circ}00'$ and
 $46^{\circ}05'N$ and by longitudes $73^{\circ}45'W$ and $74^{\circ}00'W$, and com-
prises an area of approximately 210 sq. mi.

The area is underlain mainly by the eastern part
of the Morin anorthosite mass and associated rocks,
gabbro, and by gray granite gneiss, in
probable order of age. The youngest consoli-
dated rocks are diabase dikes. All are Precambrian.
The general structural trend of the rocks of the area
is NE.

Economically, the area gives some promise in
traces of Ag and Pb, showings of titaniferous
sand and presence of consolidated rocks that may
have some future industrial use. --From auth., p. 1.

59. Duquette, Gilles. PRELIMINARY REPORT
WEEDON AREA, WOLFE AND COMPTON ELEC-

TORAL DISTRICTS: Quebec, Dept. Mines, Prelim.
Rept. no. 416, 9 p., fold. geol. map (Prelim. Map
no. 1315), scale 1:12,000, 1960, ref.

The map-area occupies about 22 sq. mi. at
 $45^{\circ}40' - 45^{\circ}45'N$, $71^{\circ}20' - 71^{\circ}25'W$. It was mapped
in 1958. The area is believed to be entirely under-
lain by Paleozoic rocks. These include: a) the
Quebec group considered to be Cambrian or Ordo-
vician in age and made up mostly of metavolcanic
rocks of various composition, structure and texture;
b) the Lake Aylmer group of formations of Siluro-
Devonian age comprising dominantly sedimentary
rocks lying unconformably above the Quebec group,
with a few porphyritic acidic and basic flows; c) 3
bodies of gabbroic rock intruding formations of the 2
preceding groups; and d) a large mass of muscovite-
biotite granite of the "Stanstead" type cropping out
abundantly in the eastern part of the map-area.

The mining property of Weedon Mining Corpora-
tion Ltd. is located in the area, and about 19 million
lbs. of Cu, 5 million lbs. of Zn, 113,500 oz. of Ag,
1,100 oz. of Au, and 200,000 tons of pyrite have
been shipped from the mine between 1913 and the end
of 1958. Some pyrite and Cu mineralization was also
found, and 2 gravel pits are being exploited. -- From
auth. p. 2, 8-9.

2-1960. Gélinas, Léopold. PRELIMINARY RE-
PORT ON THE FORT CHIMO AREA (EAST PART),
NEW QUEBEC: Quebec, Dept. Mines, Prelim. Rept.
no. 418, 6 p., fold. geol. map (Prelim. Map no.
1321), scale 1:63,360, 1960, 2 refs.

The map-area ($58^{\circ} - 58^{\circ}15'N$, $68^{\circ} - 68^{\circ}15'W$) covers
about 160 sq. mi., approximately 16 mi. E. of Chimo.
It was mapped in 1959. All the consolidated rocks
are Precambrian. A large anticline E. of Hendry
Lake has at its core biotitic and garnetiferous quartz-
feldspathic gneisses with thin beds of impure dolo-
mite and quartzite. The flanks of the anticline, as
well as other parts of the area where rock is ex-
posed, consist of quartzofeldspathic gneisses with
interstratified layers of quartzite of variable thick-
ness. The mineralogical composition of the quartz-
feldspathic gneisses is somewhat variable. SE. of
Hendry Lake many exposures contain garnet. In
other parts of the area, the gneisses pass gradually
into impure quartzites. The content of biotite and
hornblende is also variable.

Thin, lenticular masses of amphibolite outcrop
everywhere among the gneisses. They are espe-
cially abundant in the center of the anticline E.
of Hendry Lake. Pegmatite dikes cut all the gneisses
of the area. In places, they are more than 30 ft.
wide and, here and there, form irregular masses
up to 1/2 mi. in diameter. This complex of gneiss
and pegmatite is cut, in turn, by dikes of diabase.
A diabase dike approximately 1,000 ft. wide outcrops
in the northern part of the area.

With the exceptions of the pegmatite and diabase
dikes, the rocks of the area have been highly meta-
morphosed, as is shown by the presence of hyper-
sthene in the amphibolites, by olivine, diopside, and
actinolite in the impure dolomites, and by silliman-
ite in some of the other gneisses. --From auth.,
p. 1-2.

2-1961. Klugman, M.A. DONCASTER AREA, E-
LECTORAL DISTRICTS OF TERREBONNE AND
MONTREAL: Quebec, Dept. Mines, Geol. Rept. 94,
25 p., 2 maps (in pocket) incl. geol. map, scale
1:63,360, 1960, 12 refs.

The 210 sq. mi. area ($46^{\circ}-46^{\circ}15'N$, $74^{\circ}-74^{\circ}15'W$.) mapped in 1956, lies within the Grenville subprovince of the Canadian Shield. All underlying formations are Precambrian. The area includes the N.-central portion of the Morin anorthosite massif. The northern and northwestern parts of the area are underlain by quartz syenite and quartz monzonite. The Morin anorthosite massif, with an area of approximately 860 sq. mi., is surrounded on all sides by quartzose rocks of the Morin series. Small masses of Trembling Mountain gneiss and rocks of the Grenville series abut against, and penetrate, the anorthosite mass at a number of places around its margin. Bodies of Grenville series rocks are also found enclosed within the anorthosite itself. The dominant strike of the rocks, which make up the Grenville series in the vicinity of, and in, the mass, is N.

The formations of the present area, listed in order of abundance, include: anorthositic and gabbroic rocks, which underlie more than half of the area; quartzose rocks of the Morin series; paragneisses of the Grenville series; and various minor intrusive rocks.

Small occurrences of ilmenite and magnetite were observed at many places throughout the anorthosite, particularly in the more gabbroic facies. Small amounts of finely disseminated sulfides were noted in quartzose rocks of the Morin series and Grenville series. Two deposits of massive sulfides of possible economic interest were examined.--From auth., p. 1, 6, 21.

2-1962. Marleau, R.A. PRELIMINARY REPORT ON LORRAINE-FLANDRE AREA, PONTIAC ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 420, 8 p., fold. geol. map (Prelim. Map no. 1325), scale 1:63,360, 1960, 5 refs.

The Lorraine-Flandre area ($46^{\circ}30'-46^{\circ}45'N$, $76^{\circ}30'-76^{\circ}45'W$.), about 85 mi. NW. of Hull, covers about 207 sq. mi. It was mapped in 1959. All the consolidated rocks are Precambrian crystallines of the Grenville subprovince. Exposures are widely distributed, relatively small, and generally elongated NW. or W. Contacts are rarely seen, and, in most places, the geological boundaries shown on the map are "assumed." Lineation and foliation are conspicuous in most rock types.

Paragneisses are abundant in the area and are of 2 distinctive types, one with and one without inter-layered injections of granitic material. Small bodies of metagabbro occur as conformable lenses within the various gneisses. Thin layers of gray injection gneisses and granitic gneisses are present here and there in the area. Pink granitic gneisses and injection gneisses predominate in the southern half of the area. Granite and pegmatite intrude all the gneisses.

Much of the area is mantled by glacial moraine. A few eskers were noted.

Minor folds and faults, foliation, and lineation are conspicuous. Unfortunately, the relatively small size and small number of exposures in critical areas render difficult a detailed study of minor features.--From auth., p. 2, 6.

2-1963. Osborne, F. Fitz, and Thomas H. Clark. NEW GLASGOW-ST. LIN AREA, ELECTORAL DISTRICTS OF MONTCALM, TERREBONNE AND L'AS-SOMPTION: Quebec, Dept. Mines, Geol. Rept. 91, 41 p., 14 illus. of 7 pls., geol. map (in pocket), scale 1:63,360, secs. (in pocket), 1960, 22 refs.

The 210 sq. mi. map-area ($45^{\circ}45'-46^{\circ}N$, $73^{\circ}45'-74^{\circ}W$.) includes Precambrian rocks of the Canadian Shield and Paleozoic rocks of the St. Lawrence Lowlands. Both rock groups are mantled by unconsolidated Pleistocene and Recent deposits. The geology of the Precambrian region is uniform. Only 2 formations are abundant and easily mappable. Others present differ from the 2 dominant formations only as varieties or are insignificant because of their restricted exposure. Granites and granitic gneisses are the dominant rocks and probably include, as mapped, not only some Grenville rocks but also Trembling Mountain gneiss and some members of the Morin anorthosite series. Anorthosites and related rocks are almost equal in importance in the area. The Pine Hill syenites and granites are not as common here as to the W., and the Chatham-Grenville rocks are insignificantly exposed.

Although the Grenville series has given its name to this subprovince of the Canadian Shield, Grenville rocks are relatively scarce. This scarcity makes mapping difficult, for in many areas it is the distribution of the Grenville formations that gives clues to the general structure.

The lower Paleozoic rocks are Beekmantown dolomite, Chazy, Black River and Trenton limestones, and Montereian intrusive rocks. The Potsdam sandstone possibly occurs below the drift in parts of the area adjacent to the Precambrian terrain to the NW.

The geological history of the region begins with the deposition of Grenville sedimentary rocks and is followed by folding and intrusions of several Precambrian ages. After the formation of Precambrian rocks, a prolonged period of erosion developed a peneplane, across whose surface the Paleozoic seas later extended. Faulting probably contributed to the development of the Paleozoic trough, but faulting continued into a period following the deposition of the Trenton. Little is known of the Mesozoic history of this section; it was presumably a time of erosion during which the Paleozoic formations were stripped from the Precambrian region.

Economic possibilities of ilmenite, garnet, Au, limestone, sand and gravel, and clay are indicated. The high tenor of alumina in one of the anorthosite facies suggests the possibility of its future use as an ore.--From auth., p. 1, 8-10.

2-1964. Rondot, Jehan. PRELIMINARY REPORT ON CARIGNAN-HACKETT AREA, LAVIOLETTE AND PORTNEUF ELECTORAL DISTRICTS: Quebec, Dept. Mines, Prelim. Rept. no. 417, 11 p., fold. geol. map (Prelim. Map no. 1320), scale 1:63,360, 1960, 6 refs.

The area studied lies about 104 mi. from Quebec City and 149 mi. from Montreal, covering about 205 sq. mi. at $47^{\circ}-47^{\circ}15'N$, $72^{\circ}30'-72^{\circ}45'W$. All the consolidated rocks are Precambrian. Irregular bodies or lenses of paragneiss pass gradually into injection gneiss, the most abundant rock type. Charnockitic intrusions were emplaced principally in the western third of the area. In the NW. corner these rocks are in well-defined masses, whereas in the southern part the masses are rarer and less regular, and the charnockitic rocks occur chiefly as migmatites.

Pink porphyritic granite, diorite and quartz diorite cut the injection gneiss of the western two-thirds of the area. Along zones of mylonitization, corresponding to regional breaks, all the above-mentioned rocks have been altered by quartzofeldspathic injection.

GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

Close to Bastien river, 3 mafic dikes, one of which is a serpentinite, were observed. Traces of molybdenite, graphite, and radioactive elements were found.--From auth., p. 2, 10-11.

5. Sharpe, John I. PRELIMINARY REPORT OF THE STUKELY AREA, SHEFFORD AND STANSTEAD LOCAL DISTRICTS: Quebec, Dept. Mines, Techn. Rept. no. 422, 14 p., fold. geol. map (Pre-Map no. 1329), scale 1:12,000, 1960, 2 refs.

The Stukely area (45°20'-45°25'N. 72°15'-72°20'W.) covers 25 sq. mi., 72 mi. E. of Montreal. Mapping was done during 1958.

The Stukely area is underlain by steeply dipping igneous and volcanic rocks of various composition and different degrees of structural disturbance and metamorphism. The age of these rocks is probably Early Paleozoic. Dikes, sills, and plutons, ranging from ultrabasic to granitic in composition, intrude the above-mentioned rocks.

The general trend in the southwestern part of the area is northerly, but the trends change gradually northeasterly in the remainder of the area. Some evidence suggests that the area lies along the eastern margin of an anticlinorium.

Although no important amounts of metallic minerals have been previously reported in the area, the presence, within its boundaries, of a wide variety of rock types and of interesting structural features, together with the occurrences of a few miles to the SW. of an economically important Cu deposit (Quebec Copper Corporation Ltd.), makes the area significantly interesting for the possible existence of ore deposits.--From auth., p. 2, 13.

6. Sinclair, A.J. PRELIMINARY REPORT OF THE GEORGET LAKE AREA (EAST HALF), MONTENAPY ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 414, 7 p., fold. geol. map (Pre-Map no. 1316), scale 1:63,360, 1960.

The 185 sq. mi. map-area (52°15'-52°30'N. 68°0'-68°15'W.) lies about 160 mi. NNW. of Sept-Îles. The area was mapped in 1959. The area is so heavily covered by Pleistocene glacial deposits that outcrops of bedrock are generally widely scattered. Ground moraines, kames, and boulder erratics are common. The consolidated rocks of the area are Precambrian. The northern half is underlain by a medium-grained, oligoclase-quartz-mica gneiss which has a marked compositional variation from outcrop to outcrop. Thin bands of distinctly different rock types, such as feldspar-biotite-garnet schist, granite gneiss, and feldspar-muscovite schist are included in the major rock unit. A very distinctive gneiss with numerous inclusions underlies the area immediately S. of Georget Lake. This is characterized by the feldspar porphyroblasts up to 1 in. long which comprise as much as 30% of the rock.

The Fe formation sequence is very limited. However, members consisting primarily of quartzite and silicate gneiss were observed at several isolated localities.

Ultrabasic rocks are represented by 2 small intrusions which appear to be of the age of the late regional metamorphism.

The Mount Reed - Mount Wright region is noted principally for its numerous low-grade, sedimentary deposits. Economic varieties of the Fe formation sequence were not observed in the Georget Lake area by the writer, although a thin band of quartzite rock has been reported to occur on the W.

boundary, 4 mi. S. of the northwestern corner.

Several magnetic anomalies were noted in the vicinity of Pack Lake, although no causes were suggested by the exposures in the vicinity.

Sulfides, except for the minor accessory pyrrhotite in the gabbroic intrusions, are generally lacking in the rocks examined.--From auth., p. 2, 6.

2-1967. Society of Vertebrate Paleontology. GUIDE-BOOK, EIGHTH CONFERENCE, WESTERN MONTANA, edited by Robert W. Fields: 50 [15] p., illus., maps, chart, Missoula, Montana State University, 1958, refs.

The field conference was held at Montana State University, Missoula, Aug. 20-24, 1958. The guide-book contains the following road logs and papers:

Logs and maps of conference routes, p. 6-7.

First day of Eighth Field Conference (Missoula, Butte, and Pipestone Springs), p. 8-13.

Second day of Eighth Field Conference (Pipestone, Anceney, Virginia City and return), p. 13-15.

Third day of Eighth Field Conference (Pipestone, Dillon, Dell, Alder and return), p. 16-18.

Fourth day of Eighth Field Conference (Pipestone, Helena, Townsend and return), p. 19-21.

Honkala, Fred S. Geology between Missoula and Pipestone Springs, Montana, p. 22-24.

Orr, James B. The Tertiary of Western Montana, p. 25-33.

Kay, J. LeRoy, Robert W. Fields, and James B. Orr. Faunal Lists of Tertiary Vertebrates from Western and Southwestern Montana, p. 33-39.

Hough, Jean R. Tertiary Beds of the Sage Creek Area, Beaverhead County, Montana, p. 41-45.

Konizkeski, R., and J.C. Donohoe. Faunal and Stratigraphic Relationships of the Cabbage Patch Beds, Granite County, Montana, p. 45-49.

Dorr, John A., Jr. Latest Miocene Anceney Local Mammal Fauna from Montana, p. 50.

The appendix (15 p.) consists of a facsimile reproduction of the first scientific work in this field published by Montana State University, entitled The Neocene Lake Beds of Western Montana and Descriptions of Some New Vertebrates from the Loup Fork. It was published originally as Montana State University, Bulletin no. 1, in 1899.

2-1968. Dickey, Dayton D., and Francis A. McKeown. GEOLOGY OF DOLOMITE HILL, NEVADA TEST SITE, NYE COUNTY, NEVADA: U.S. Geol. Survey, Trace Elements Inv. Rept. 755, 64 p., 2 maps (geol. map in pocket), diag., 5 tables, Nov. 1959, 2 refs.

This describes the structure, stratigraphy, petrology, and chemical composition of Dolomite Hill, Nevada Test Site. Much of the information is based on analysis of a 1,200-ft. core hole drilled near the top of the hill. The rocks consist of thin- to thick-bedded dolomite of the undifferentiated Devils Gate and Nevada formations of Middle and Late Devonian age, overlain with angular unconformity by tuffaceous Tertiary rocks of the Oak Spring formation. The dolomite beds dip W. to NW. and are cut by a series of NE-trending faults with displacements of as much as 80 ft. Some of the faults contain quartz veins as much as 4 ft. wide and 500 ft. long. Appendix contains lithologic log of the drill hole.--M. Russell.

2-1969. Odintsov, M.M. GEOLOGY OF THE ANGARA REGION. Translated by Cyril Muromcew:

Internat. Geology Rev., v. 2, no. 4, p. 346-350, 4 illus., Apr. 1960.

Industrial development of the Angara region has necessitated geological exploration for available resources. The Angara river flows N. from lake Baikal, intersecting the mountains surrounding it, passes through the 'Irkutsk amphitheater,' part of the central Siberian platform, and, near Bratsk, flows across a diabase intrusion, forming the Bratsk rapids (approximately 300 km. long).

The Angara river basin is underlain by crystalline basement (the Siberian craton) composed of schists, gneisses, marble, and Archean and Proterozoic granites. These rocks dip sharply from the Sayan and Baikal ranges, where they outcrop, toward the Irkutsk amphitheater, where they reach 3,000 m. depth. The craton is covered by sediments ranging in age from Cambrian to Quaternary. Lower Cambrian rocks over 2,500 m. thick are overlain by Middle Cambrian strata which are generally eroded. In the Irkutsk coal basin, N. of lake Baikal, Mesozoic rocks 600 m. thick are covered unconformably by Tertiary sediments. Quaternary deposits are known to occur; the Angara river terraces are probably pre-Quaternary. Regional tectonics involved fracturing within the Irkutsk amphitheater and in the surrounding mountains. Geophysical survey and drilling revealed a wide horizontal protrusion (the 'Angara swell') in the Siberian craton; this protrusion divides the Irkutsk amphitheater in the pre-Baikal and pre-Sayan depressions. Overlying Cambrian sedi-

ments are folded in conformity with these basement-complex dislocations. Jurassic deposits, generally horizontal, are disturbed only near the younger uplifts of Sayan and Baikal. The southwestern part of a large trap-rock intrusion crosses the Irkutsk amphitheater; concordant intrusions, e.g. sills, enter lower Paleozoic sediments along with dikes during late Permian and, principally, Triassic times.

Mineral deposits are rich and varied. Precambrian rocks contain magnetic Fe ore (of the Krivoy Rog type), talc, magnesite, pure crystalline limestone, and, possibly, phosphates. Paleozoic rocks contain large marine and lacustrine salt deposits, gypsum, phosphatized shell rock, and, possibly, oil, as well as carbonaceous rocks with Pb and Zn minerals. Hydrogen sulfide-saturated and saline mineral waters as well as subsurface water with high K content occur in Cambrian rocks. Siberian trap rocks are rich in Mg and Fe; Mg-magnetite ores occur in volcanic necks as large veins of pure ore associated with tuffs and aureoles. Trap rock (diabase) may be used in the new stone-melting industry. Jurassic deposits include saprolitic-bog and humus coals as well as extensive fire-clay and high-quality kaolin deposits. Cambrian fossils include trilobite and brachiopod remains, reefs, and molluscs; fish, insects, ostracods, and numerous fossil plant traces are representative of the Mesozoic. The Angara river terraces, 25 to 30 m. thick, contain mammal remains, brackish-water molluscs, and, from the middle Paleolithic, Azilian and Solutrean artifacts. --D.D. Fisher.

2. GEOMORPHOLOGY

See also: Structural Geology 2-1994; Geophysics 2-2078; Sedimentary Petrology 2-2108; Geohydrology 2-2125.

2-1970. Powers, William E., and Clyde F. Kohn. AERIAL PHOTO-INTERPRETATION OF LANDFORMS AND RURAL CULTURAL FEATURES IN GLACIATED AND COASTAL REGIONS: Northwestern Univ., Dept. Geography, Studies in Geography, no. 3, 111 p., approx. 100 illus., maps, July 1959, refs.

This monograph is designed to contribute to a fuller and more effective use of aerial photographs in geographic research. Several types of keys are included for the aerial photographic identification of both physical and cultural features. It is hoped that the use of these keys will enable geographers to achieve greater speed and accuracy in their research.

The monograph consists of 3 parts. Pt. 1 deals with the aerial photographic identification of principal landform types developed by continental glaciation, of shoreline features associated with glacial landforms, and of landforms in a dry grassland marginal to glaciated plains.

Pt. 2 sets forth keys for the aerial photographic identification of selected farm crops, rural settlement features, and seaside resorts. The aerial photographic appearance of each physical and cultural feature described in this report was studied in aerial stereograms and then carefully checked by ground observation in the field. Representative features were photographed from the ground, generally in stereo, so that their actual appearance could be presented to the user of each key. A number of these ground stereopairs are included in the monograph.

Pt. 3 represents a geographic method of aerial photographic identification.

All figures are placed at the end of the chapters to which they refer and are numbered consecutively by chapter. With most of them it is essential to use a lens stereoscope to observe the features described --From auth. pref.

2-1971. Donn, William L. PLEISTOCENE CLIMATE: New York Acad. Sci., Trans., v. 22, no. 7, p. 491-493, May 1960, 3 refs.

The Ewing and Donn theory of Pleistocene glaciation is summarized. Continental glaciers are possible only where sufficient moisture is available from a nearby ice-free ocean to support them. An initially ice-free Arctic Ocean preceded the first glacial stage which began after the poles had become located in their present thermally isolated positions. With subsequent lowering of sea level, inflow of warmer water from the North Atlantic was restricted to the point at which the Arctic Ocean froze over, thus cutting off the source of moisture and initiating the first interglacial stage. Subsequent alternations of glacial and interglacial stages followed and will continue so long as the above conditions prevail. --M. Russell.

2-1972. Broecker, Wallace S., Maurice Ewing, and Bruce C. Heezen. EVIDENCE FOR AN ABRUP CHANGE IN CLIMATE CLOSE TO 11,000 YEARS AGO: Am. Jour. Sci., v. 258, no. 6, p. 429-448, diags., graphs, June 1960, 35 refs.

Evidence from a number of geographically isolated systems suggests that the warming of world-wide climate which occurred at the close of Wisconsin glacial times was extremely abrupt. Surface ocean temperatures in the Atlantic Ocean increased by sev-

degrees centigrade, and deep-sea sedimentation sharply decreased in the equatorial Atlantic. Bottom waters of the Cariaco trench, a restricted sea in the Caribbean, abruptly stagnated. The plumes in the Great Basin rapidly shrank from their maximum volume to nearly their present size. The clay which was flushed into the Gulf of Mexico during the glacial period was suddenly retained in the coastal valley and delta of the Mississippi River and glacially-dammed Great Lakes drainage was retarded to the northern outlet. As indicated by pollen studies a pronounced warm period in northwestern Europe also occurred at this time. In each case the radiocarbon age determinations suggest that the changes occurred in less than 1,000 years close to 10,000 years ago.--Auth.

73. Ogden, J. Gordon, 3d. RECURRENCE SURFACES AND POLLEN STRATIGRAPHY OF A POSTGLACIAL RAISED BOG, KINGS COUNTY, NOVA SCOTIA: *Am. Jour. Sci.*, v. 258, no. 5, p. 341-353, 1960, map, May 1960, 28 refs.

Pollen analysis of a core from a postglacial raised bog at the head of the Annapolis River valley, Kings County, Nova Scotia, has revealed the presence of 5 periods of peat growth. These periods of peat growth are recognized by the occurrence of a light-colored *Sphagnum* peat overlying a dark-colored humified *Sphagnum* peat. The stratigraphy and microfossils of the light- and dark-colored peat layers are closely similar to those of European raised bogs. Recurrence surfaces in Europe have been dated by pollen stratigraphy, archeology, and by radiocarbon methods. Many recurrence surfaces have been found to be approximately the same age over wide areas. Periods of peat growth (as shown by the development of lighter colored less humified peats) have been found to correspond with periods of increased atmospheric moisture.

Terrestrial rhizopods in the light-colored peat layers of Caribou bog confirm the similarity of the recurrence surfaces of this bog with those of western Europe and Scandinavia. Chronologic equivalence of Caribou recurrence surfaces with those of northern Europe and Scandinavia cannot be established from this study.

Alkali-extracts of the peat have been used to characterize the sediment color differences above and below the recurrence surface horizons. A simpler technique, based on sieved fractions of the sediment, is satisfactory and less time-consuming for describing differences in sediment color density.

The pollen stratigraphy of core CAR-1 resembles the pollen sequence described by Auer from the Caribou bog. Correlation of the Caribou bog sequence data from Gillis Lake on Cape Breton Island and Aroostook County, Maine, is also discussed. There is no evidence for any major climatic reversal. The pollen data indicate a gradually warming climate with minor oscillations of moisture (and temperature).--Auth.

74. Giles, Gordon C. NISQUALLY GLACIER, MOUNT RAINIER, WASHINGTON. 1959 PROGRESS REPORT: U.S. Geol. Survey, Repts., Open-File Ser. 513, 31 p., 5 figs. incl. profiles, 5 tables, March 1960.

The recession of the terminus and wastage of the upper half mile of the glacier continues as in the past. Between the years 1910 and 1958 the drop in surface

elevation exceeded 400 ft. along one section of the glacier. The advance of the ice face near the upper end of the lower nunatak was considerably less this past year than in previous years, yet there was no appreciable change in the volume of ice upstream from this area. The rate of surface movement near cross-profile no. 2 showed a very pronounced decrease ranging up to 30% between 1958 and 1959, yet the surface elevation of the glacier showed an average increase of about 1 ft. during this period. At cross-profile no. 1 there was no significant change in surface elevation between 1958 and 1959; however, at cross-profile no. 3 the 1959 surface was on an average of 17 ft. higher than the 1958 surface.

Longitudinal profiles show a continuous shrinkage of the glacier surface downstream from the 5,100-ft. level since 1910. Wastage of over 400 ft. in mean altitude occurred at one section of the glacier during this period. Upstream from the 5,100-ft. level the glacier surface has been fluctuating at periodic intervals. New ice appears to be moving into this area, causing a less pronounced change in surface elevation than is shown for the terminal zone. The amount of ice flowing into this area appears to increase and decrease considerably at periodic intervals, which seems to point to a cyclic pattern of behavior. Although the last wave of ice that moved down glacier was larger than the preceding wave, the total volume of ice in the terminating and terminal zones is less today than it has been since measurements began. This would indicate that the general trend is still towards glacier recession.--Auth. summ.

2-1975. Derruau, Max. UN PROBLÈME MORPHOLOGIQUE DE LA RÉGION DU LAC-SAINT-JEAN [A MORPHOLOGICAL PROBLEM IN THE LAKE SAINT JOHN REGION]: *Cahiers de Géographie de Québec*, v. 3, no. 6, p. 149-152, illus., 5 secs., Apr.-Sept. 1959; text in French.

Two areas near Lake St. John are briefly described. In the Elysée-Saint François de Sales area, terrace deposits are found which were formed under lacustrine or marine conditions and associated with glacial kettles and an esker. They are situated slightly above the level of the former Champlain sea. Two alternative explanations are put forward, the first being sedimentation on a plain graded to the base level of this sea. According to the second hypothesis they were formed in lakes dammed up by ice masses left behind by the receding and melting continental ice sheet. On the plain in which Lake St. John is situated many kettles and cavities are found as well as hills and hummocks of sand and gravel, due to the action of the inland ice and of subglacial streams. The relation of the sand and gravel ridges to the Champlain clay is not clear yet. They may lie on the clay in which case they were formed by a gravel-carrying ice mass floating on the Champlain sea and grounded at the time the sea level was lowered, or by a later glacial recurrence. It may also be that the clay was deposited alongside remains of an ice sheet covered at a later stage by the Champlain sea.--C. Voûte.

2-1976. Mackay, J. Ross. GLACIER ICE-THRUST FEATURES OF THE YUKON COAST: *Geog. Bull.*, no. 13, p. 5-21, 7 figs., 3 tables, 1959, 28 refs.

Deformation of Pleistocene or earlier sediments found along the Yukon coast between King Point and Herschel Island are believed to have been caused by glacier ice-thrust. The paper describes major de-

formations occurring at Herschel Island, Kay Point, King Point, and Stokes Point. The extent of glaciation within the immediate area is discussed, and 3 mechanisms are suggested as possible causes for the deformation of the sediments: slumping, tectonic disturbance, and ice-thrusting. In support of the ice-thrust theory, the most acceptable of the 3, the following methods have been advanced to explain disturbed deposits: the frictional drag of glacier ice over weak strata, the incorporation of subglacial beds as englacial material, the bulldozing effect of glacier ice, and the overriding pressure of glacier ice over topographical obstructions. It is believed that deformation was caused by the overriding pressure of glacier ice over sediments whose sheer strength was reduced by high neutral stresses in entrapped pore water.--Auth.

2-1977. Sharp, Robert P. **PLEISTOCENE GLACIATION IN THE TRINITY ALPS OF NORTHERN CALIFORNIA**: *Am. Jour. Sci.*, v. 258, no. 5, p. 305-340, 7 illus., 13 maps, secs., May 1960, 31 refs.

The glacial sequence of the Trinity Alps has good development, significant location, and value as a reference datum for other Pleistocene events. The principal glacial episodes identified are Late (Morris Meadow), Middle (Rush Creek), Early (Alpine Lake) and Ancient (Swift Creek). The 3 youngest are judged Wisconsin, the oldest pre-Wisconsin. Other evidence suggests possibly still older glaciations, and youthful moraines at high elevations may be Neoglacial (post-Hypsithermal).

During the Late (Morris Meadow) glaciation, the Trinity Alps contained at least 30 valley glaciers. Maximum lengths and lowest elevations attained are: Late, 7.8 mi. and 3,350 ft.; Middle, 9.3 mi. and 2,800 ft.; Early, 11.3 mi. and 2,500 ft.; Ancient, 13.7 mi. and 2,450 ft. Length was more variable than terminal elevation.

Where the glacial detritus was derived largely from serpentine, numerous debris flows extended down-valley from glacier snouts. Deposits of flow debris, almost indistinguishable from till, complicate interpretation of glacial relations on lower Deer and Swift creeks.

The rock floors of stream terraces, well exposed in abandoned placer workings along Canyon Creek, lie at 10, 20, 40, 90, 160, and 300 ft. above the stream. Direct tracing to terminal-moraine positions suggests that the 10-, 20-, and 40-ft. rock-terrace levels are chronologically, but perhaps not genetically, related to the Late, Middle, and Early phases of Wisconsin glaciation. The 90-ft. terrace may be a time-equivalent of the Ancient glaciation (pre-Wisconsin), and the 160- and 300-ft. terrace could be chronologically related to still earlier Pleistocene glaciations.

In the high country, carapaces of ice formed on sloping valley walls above the level of the ice streams partly filling the valleys. Two vestigial glacierets remain at elevations of 8,200-8,400 ft. on the N. side of the Thompson Peak ridge. Wisconsin orographic snowline lay at 6,500 ft., climatic snowline at about 8,000 ft. Corresponding figures for the present are judged to be about 7,500 and 9,000 ft. Wisconsin orographic snowline rose inland 18 ft. per mi., judging from data obtained on Mt. Lassen, 85 mi. to the ESE.--Auth.

2-1978. Rowley, Joanne. **A PRELIMINARY POLLEN STUDY FROM A FOSSIL BISON SITE IN ST. PAUL, MINNESOTA**: *Minnesota Acad. Sci., Proc.*,

v. 25/26, p. 40-50, fig., table, 1957/1958, pub. 1960, 25 refs.

The drift association shows that the Trout Brook deposit sampled is definitely at least as recent as Cary in age. The vegetation indicates that the zone in which *Bison occidentalis* was found is also more recent than Two Creeks. Since evidence of spruce and pine zones is lacking, it is a reasonable surmise that *B. occidentalis* lived in an environment similar to that of the present in this area, probably more recently than about 8,000 years ago.--Auth. summ.

2-1979. Forsyth, Jane L. **CORRELATION OF TILLS EXPOSED IN TOLEDO EDISON DAM CUT, OHIO**: *Ohio Jour. Sci.*, v. 60, no. 2, p. 94-100, 3 figs., March 1960.

An exposure in the E. bank of the Auglaize River, just downstream from the Toledo Edison Dam, 3 mi. S. of Defiance, Ohio, reveals 2 tills, separated by a cobble pavement and overlain by lacustrine and alluvial deposits. The upper till is clay-rich, with a mechanical analysis that fits within the ranges of both the late Cary till of northeastern Ohio and the upper till of southern Ontario. The lower till is much sandier, with a mechanical composition that fits within the ranges of the sandier Tazewell till of northern Ohio and the lower till of southern Ontario.

One sample of this lower till, taken not far beneath the contact with the upper till, has a mechanical composition more like that of the early Cary till of northeastern Ohio, suggesting that in this area there was a transition, near the end of the time during which the lower till was deposited, to conditions leading to the deposition of a till more like that of the early Cary.

Because the mechanical analyses of the tills and their relative stratigraphic positions are almost the same in northeastern Ohio, southern Ontario, and in the Toledo Edison dam cut, it is inferred that the glacial history of the 3 areas must have been almost the same, thus providing a basis of correlation between these areas.

Radiocarbon determinations give a date of 24,000-27,000 years ago for the advance of the glacier which deposited the lower sandy till. By about 12,000 years ago, both the sandy and clayey tills had been deposited, and the ice had made its final retreat from the area. On the basis of comparison with radiocarbon dates in Illinois, this ice advance and retreat appear to have occupied the entire classic Wisconsin interval.--Auth.

2-1980. Lessig, Heber D. **THE SUPERMARKET TERRACE, NEAR EAST LIVERPOOL, OHIO**: *Ohio Jour. Sci.*, v. 59, no. 6, p. 332-338, 3 figs., Nov. 1959.

A terrace remnant at 800-850 ft. elevation, which is part of a general terrace level in the upper Ohio Valley, occurs in the E. part of East Liverpool, Ohio. It has 25 ft. of highly weathered sand and gravel mantled by colluvium about 8 ft. thick. A 12 ft. thick solum development and 25 to 30 ft. thick zones of weathering and leaching indicate that the glacial outwash belongs to a pre-Illinoian glaciation of the Allegheny Plateau, but it is younger than the earliest glaciation whose outwash lies at 960-1,020 ft. elevation. A deep modern soil is formed through the colluvium into the glacial outwash, but no buried paleosol occurs between these 2 materials. This indicates that the depositions of the outwash and the colluvial

antle were nearly contemporaneous and that the black colluvium of the region is pre-Illinoian.--Auth.

1981. Cass, L. A., and R. D. Miller. **ROLE OF THE ELECTRICAL DOUBLE LAYER IN THE MECHANISM OF FROST HEAVING:** U.S. Snow, Ice & Permafrost Research Establishment, Research Rept. 49, 23 p., 3 diagrs., graph, Aug. 1959, 21 refs.

The phenomenon of osmotic pressure is a well-known property of aqueous solutions. The swelling of clays may be regarded as an osmotic phenomenon, and calculations based on the Gouy-Chapman model of the electrical double layer predict the swelling properties of ideal clays. Heaving can be produced in an osmometer, with the uplift a manifestation of the osmotic pressure of the solution. It follows that the osmotic activity of the electrical double layer on mineral particles can account for the heaving phenomenon in ideal soils.

If this hypothesis is correct, it is possible to calculate the relationships between the osmotic pressure (and freezing temperature) of water in contact with the base of a growing ice lens and the other significant variables. These are: overburden pressure, depth to water table, depth to conducting stratum, hydraulic conductivity of the soil, and rate of heave. Equations relating these variables are presented.

According to these concepts, the flow of water to the ice face is ordinarily by hydraulic conduction except in the unfrozen film between the uppermost particles and the underside of the ice lens. Here movement is by diffusion, and the failure of coarse materials to show significant heave is shown to be due in part to limitations imposed by the diffusion on the recharge of the unfrozen film.

A theory of supercooling recently outlined by Jackson and Chalmers is based on the contention that the energy required for the heaving process is derived from the conversion of supercooled water to ice. They conclude that some degree of supercooling is essential if frost heaving is to take place. The present theory denies this requirement, proposing a "solution model" in which heaving can occur in the absence of soil.

Recognized and proposed methods of modifying or controlling frost heaving are reviewed from the point of view of the theory presented. Experiments are proposed for evaluating the theory by verification of temperatures at the frost line predicted from the relationships mentioned above. To be successful, such experiments would require techniques of more than ordinary precision.--Auth. summ.

1982. Cook, Frank A. **SOME TYPES OF PATTERNED GROUND IN CANADA:** Geog. Bull., no. 13, p. 73-81, 13 illus., 1959, ref.; text in English and French.

A photo study illustrating some types of patterned ground found in Canada.--Auth.

1983. Cook, Frank A. **A REVIEW OF THE STUDY OF PERIGLACIAL PHENOMENA IN CANADA:** Geog. Bull., no. 13, p. 22-53, 2 tables, 1959, 85 refs.; text in English, resumé in French.

The study of periglacial phenomena in Canada is in its infancy, and as yet very little is known of the distribution of these phenomena. Before World War I most of the area under the influence of a periglacial climate was relatively inaccessible, and con-

sequently there are only casual references to periglacial phenomena in Canadian literature prior to 1940. The opening up of the N. has increased the interest of Canadian geographers and geologists in the active periglacial forms, principally patterned ground and permafrost. This paper brings together selected references and discusses the present stage of development of the study of periglacial processes and phenomena in Canada.--Auth.

1984. Cailleux, André. **OBSERVATIONS SUR QUELQUES LACS RONDS NORD-AMÉRICAINS [OBSERVATIONS ON SOME CIRCULAR NORTH AMERICAN LAKES]:** Cahiers de Géographie de Québec, v. 3, no. 6, p. 139-147, 15 illus., Apr.-Sept. 1959, 15 refs.; text in French.

A list is given of round pools and vegetation patches, which have been observed from the air during flights on scheduled airlines, the first set seen along the New York-Los Angeles line between Cleveland and the Mississippi, the second on a flight from Los Angeles to Frobisher Bay. The observations are compared to some detailed topographic maps of the United States and Canada. The pools and patches can be partly explained as a possible result of the melting of ground ice or of frost mounds. Similar periglacial phenomena are widely spread over North America and Europe.--C. Voûte.

1985. Moss, H. C. **MODERN SOIL SCIENCE (PEDOLOGY) IN RELATION TO GEOLOGICAL AND ALLIED SCIENCES:** Royal Soc. Canada, Trans., Sec. 4, Geol. Sci., v. 53, p. 27-35, 1959, 23 refs.

An introduction to the viewpoint of the pedologist on the nature of the soil and the place of soil science among other earth sciences. To the pedologist the soil is an independent natural body, and its study forms a distinct and separate branch of natural science. To explain this concept, the soil-forming factors - climate, vegetation, parent material, topography, and time - are discussed briefly, and the soil profile is defined. Monoliths of some western Canadian soils are exhibited. In addition, the following suggestions are presented and discussed: 1) natural soils should be identified and described according to the methods of pedology; 2) geological and related studies of the regolith should take account of pedological aspects; 3) the soil classification and soil map can be a valuable aid to the interpretation of the geology and geography of a given area; 4) a wider recognition and use of pedology in other sciences will assist pedological research.--Auth.

1986. Sittler, Robert F., and Jack Baker. **THICKNESS OF LOESS IN CLARK COUNTY, ILLINOIS:** Ohio Jour. Sci., v. 60, no. 2, p. 73-77, 3 figs., March 1960.

A systematic study of loess thicknesses in Marshall and Casey quadrangles in Clark County, Illinois, shows that: 1) the thickness of loess varies from over 100 in. near the bluffs of the Wabash River to 24 in. on the Shelbyville moraine; 2) the thinning of loess away from the bluff can be expressed by the equation: $Y = 87 - 36 \log X$; 3) the loess near the bluffs contains a larger amount of sand and less further away from the river; 4) the Shelbyville moraine has some effect on increasing the thickness towards the moraine instead of towards the Wabash River; 5) the loess is of wind-blown origin, being

derived in the main from glacial outwash.--Auth.

2-1987. Fairbridge, Rhodes W. **THE CHANGING LEVEL OF THE SEA:** Sci. American, v. 202, no. 5, p. 70-79, 2 illus., 2 maps, secs., graphs, May 1960.

Scientists, seeking evidence for the world-wide deluge recorded in legends of many lands, and allowing for reasonable exaggerations, find that a relatively rapid drowning of highly populated coastal lowlands would provide an explanation. The ending of the latest of the 4 great ice ages recorded since late Precambrian is the cause of the legends. This has resulted in a partial return to catastrophism over uniformitarianism.

Both water locked up as ice and isostatic adjustments affect sea level, with the former, at least in part, causing the latter. World-wide tide gauge measurements over many years show isostatic rebound of glaciated areas of as much as 11 mm. per year and a variety of other sea level changes. Sea level has been rising an average of 1.2 mm./year for 50 years, and long term sea floor subsidence of about .02 mm./year partly counters this trend.

After a fall of 330 ft., 17,000 years ago, sea level rose at the rate of 40 in./century, with short spurts of as much as 30 ft./century. The fastest spurt 6,000 years ago is recorded in the "great flood" legends. Excellent graphs show details of sea level change and associated phenomena.

Sea level is a delicate paleoclimatic indicator, and the record seems to indicate an early end to the Quaternary ice age and a very rapid "deluge" as the Antarctic and Greenland ice caps melt and pour 330 ft. more water into the ocean.--R. F. McAllister.

2-1988. Ahnert, Frank. **ESTUARINE MEANDERS IN THE CHESAPEAKE BAY AREA:** Geog. Rev., v. 50, no. 3, p. 390-401, 2 illus., map, 3 diag., July 1960, 13 refs.

The action of reversing tidal currents causes estuarine meanders to differ greatly from meanders in rivers above tidewater. They consist of a succession of oblong pools connected by narrow channels, and are almost entirely imbedded in recent tidal marshes. The narrows are usually located at the bends. The pools are kept wide by the lateral displacement of the meandering flood currents and ebb currents toward opposite banks of the estuary. Estuarine meanders are best developed in a middle stretch of the estuary, where ebb and flood currents occur with about the same velocities, and where their maximum velocity is reached at about the same water level. Landward from this stretch the estuary differs little from a "normal" river bed; seaward it is a broad open funnel.

Silt deposition on the tidal marshes at high water appears to be as important a factor in the development of estuarine meanders as lateral erosion by the tidal currents. Silt is supplied by streams and rivers entering the estuary. However, the silt deposits grow seaward only very slowly, as the seaward silt transport is partially counteracted by a landward transport during the times of flood current.

Dynamically, estuarine meanders represent an intermediate stage in the development of an estuary from an open funnel to a fluvial flood plain. They are common not only around Chesapeake Bay, but also on other parts of the Atlantic coast, and have been noticed on the coasts of other continents as well.--Auth.

2-1989. Zenkovich, V. P. **STUDY OF THE SEASHORES OF THE CHINESE PEOPLE'S REPUBLIC.** Prepared by U.S. Joint Publications Research Service: Internat. Geology Rev., v. 2, no. 4, p. 354-356, 2 illus., Apr. 1960.

The coast line of the Chinese People's Republic, more than 12,000 km. long, is becoming increasingly important as an industrial site and as a potential source of raw materials. The author participated in the organization of research on coastal dynamics and morphology in several areas.

During investigation of silt deposition in the port of Hsin-kang, a collection of data on movement of saturated turbid suspensions under natural conditions has been obtained for the first time. Other areas under investigation include: Liaotung and Shantung peninsulas, Hang-chou bay and the Yangtze river mouth, Lei-chou-wan Tao peninsula (Kwangtung province), and Hainan island. A seacoast studies laboratory was organized recently in the Oceanographic Institute at Tsingtao; research programs are developing at Peiping University, Shanghai Teacher's Institute, and at Sun Yat-sen University in Canton. Perhaps the most difficult problem encountered was lack of data from previous studies or from hydrological observations.

Present studies indicate that the seacoasts composed of silt develop uniquely; evidently their stability is determined by changing equilibrium between deposition of silty material into the ocean from river mouths and the amount of material stirred up and removed from the coastal zone by wave action. A low gradient (1:2,000) is characteristic of the great Chinese plain, the drainage belt, and the shoals. Mountainous coastal areas are of the ria type, fringed by an archipelago of small islands. Along embayed, or incised, areas of the coast line, sandy material tends to accumulate; heavy-mineral accumulations are to be found in these areas.

Additional joint Soviet-Chinese coastal-zone studies are proposed under sponsorship of the Chinese People's Academy of Sciences; a planned study on latitudinal zonality in coastal processes will involve comparison of data for the Pacific Ocean coast line from the Bering Strait to the tropics.--D. D. Fisher.

2-1990. Scholl, David W., and Cleo L. Sainsbury. **MARINE GEOLOGY AND BATHYMETRY OF THE NEARSHORE SHELF OF THE CHUKCHI SEA, OGOTORUK CREEK AREA, NORTHWEST ALASKA:** U.S. Geol. Survey, Trace Elements Inv. Rept. 606, 68 p. 24 figs. (12 in pocket) incl. illus., maps, secs., profiles, graphs, 4 tables, Aug. 1959, 45 refs.

During July and Aug. 1958 the U.S. Geological Survey conducted a study in behalf of the U.S. Atomic Energy Commission of the oceanography, bathymetry, and marine geology of the nearshore shelf of the Chukchi Sea off the Ogotoruk Creek area, NW, Alaska. Ogotoruk Creek enters the Chukchi Sea about 32 mi. SE. of the large cusped spit of Point Hope at 165°-44'46"W. and 68°05'51"N. The Ogotoruk Creek area extends approximately 10 mi. W. and 7 mi. E. of the creek mouth. Knowledge of the marine geology and oceanography is confined primarily to the nearshore shelf, which includes about 70 sq. mi. of the shelf and is defined as the sea floor lying shoreward of the 50-ft. submarine contour. The 50-ft. contour generally lies from 2 to 4 mi. from shore. Submarine topography was studied to a distance of 15 mi. from shore over an area of approximately 340 sq. mi.

A NW. coastal current flows past the Ogotoruk

pek area and during July and Aug. averaged 0.5 p.h. Persistent northerly winds caused general swelling near shore, and at times of pronounced upwelling the coastal current was reversed or appreciably reduced in speed. Longshore currents shoreward of the breaker zone averaged 0.3 m.p.h. and veered to the E. for the greater part of the time of study.

The over-all seaward slope of the inner 15 mi. of Chukchi shelf from a depth of 40 to 135 ft. is approximately $0^{\circ}04'$, or about 6 ft. per mi. Slopes near shore to depths of 15-20 ft. are steep and average $2^{\circ}30'$. Beyond these depths they decrease gradually out to a depth of 40-45 ft. Seaward of this point the shelf is flattest and slopes are as low as $0^{\circ}01'$. This terrace or flat part of the nearshore shelf is about 2 mi. wide and descends to a depth of 50-55 ft. Beyond which the gradient increases to about $0^{\circ}06'$. At depths greater than 85 ft. the submarine declivity gradually decreases to $0^{\circ}03'$ at a distance of 15 mi. from shore.

A flat-bottomed trough, Ogotoruk sea valley, heads but a quarter of a mile from shore off the mouth of Ogotoruk Creek. The shallow sea valley averages only 6 ft. in relief and extends 15 mi. from shore to a depth of 135 ft. A number of smaller channels also lent the gentle sloping inner Chukchi shelf E. of the sea valley and nearshore W. of it.

Many outcrops of Paleozoic and Mesozoic formations on the nearshore shelf indicate that it is a wave-eroded platform. Wave planation is thought to have taken place primarily in Sangamon and pre-Sangamon time (approximately 100,000 to 1,000,000 years ago). Ogotoruk sea valley is believed to be a drowned subglacial valley which was excavated by Ogotoruk Creek during periods of glacially depressed sea level.

Unconsolidated sediments overlying the nearshore shelf are chiefly slightly rounded residual gravel derived from submerged outcrops. Detrital sand and silt, contributed from the nearby coastal area during Recent time, overlies the shelf near shore and to a depth as much as 50 ft. seaward of segments of the coast underlain by fine-grained clastic rocks of Mesozoic age. Owing to a small volume of detrital sands contributed by the coastal area, detrital sedimentation is not prominent over the nearshore shelf.

Beaches fronting the Ogotoruk Creek area are 30-100 ft. wide, range from less than 10 to about 25 ft. thick, and are composed of sandy gravel having a median diameter of about 10 mm. Rounded clasts of graywacke, siltstone, limestone, and chert are the principal constituents of the gravel. Longshore currents accompanying moderate storms transport gravel and sand parallel to shore at rates of 5 cu. yds. per hour. Sediment transported by longshore currents accumulates as spits at stream mouths and in areas of new beach below rocky headlands.--Auth.

1991. Corbel, Jean. LES ALPES INUITIENNES [THE INUITIAN ALPS]: Cahiers de Géographie de Québec, v. 3, no. 6, p. 417-455, 12 illus., 9 maps, 2 secs., 2 graphs, 3 tables, Apr.-Sept. 1959, 40 refs.; text in French.

A concise description is given of the geography and geology of a region extending from Ungava Bay to the northern point of Ellesmere Island, comprising about 800,000 sq. km. of mountain area with an average elevation of 950 m. and maximum altitudes of 3000 m., of which 150,000 sq. km. are covered by glaciers. Slightly folded sediments occur in several basins, covering the extensively block faulted Pre-Cambrian. A zone of strongly folded Silurian and

older, moderately folded Permo-Carboniferous to Lower Cretaceous and slightly folded Miocene extends through Ellesmere Island and the Parry Islands. Two major erosional surfaces are recorded, the first post-Silurian, the second formed during the Cretaceous and early Tertiary, fossilized by Miocene sediments, and disturbed by upheaval, tilting, and block faulting. Climate, vegetation, and some features of the actual glaciers are described. Emphasis is laid upon glacial and periglacial erosion and its influence on morphology, a distinction being made between permafrost features under dry and under humid climatic conditions. The thickness of the ice cap, which covered the whole area during one single uninterrupted glacial period, is calculated along different lines to have been more than 3,000 to 4,000 m. in the Baffin Island area. The moving ice masses scored deep and wide valleys along zones of structural weakness, e.g. Hudson Strait. The directions of the smaller glacial valleys are also commanded by fault and joint patterns. The article finishes with a paragraph on the past and present human occupation of the area.--C. Voûte.

2-1992. Dove, George D. DRAINAGE OF THE TEAYS-STAGE MOUNT VERNON AND CAMBRIDGE RIVERS: Ohio Jour. Sci., v. 60, no. 2, p. 122-124, fig., March 1960.

The Mount Vernon River and its principal tributary, the Cambridge River, drained most of E.-central Ohio during Teays (late Tertiary) time. The Mount Vernon River's headwaters were in the highlands of Wayne and Ashland counties. From its headwaters, the Mount Vernon River flowed past Wooster to Perrysville and thence past Mount Vernon to the Knox-Licking county line. Formerly it was thought the stream that flowed from Mount Vernon entered Licking County near Utica; however, present findings reveal the river entered Licking County near Homer and flowed past Johnstown to Pataskala, thence into Fairfield County. In Fairfield County, near Pickerington, the Mount Vernon was joined by the Cambridge River.

The headwaters of the Cambridge River were in Guernsey and Noble counties. From its headwaters, the Cambridge River flowed past Cambridge to West Lafayette and thence past Conesville and Frazey'sburg to Newark. From Newark the Cambridge flowed past Hebron and Millersport to its junction with the Mount Vernon River near Pickerington.--Auth.

2-1993. Langford-Smith, T. THE DEAD RIVER SYSTEMS OF THE MURRUMBIDGEE: Geog. Rev., v. 50, no. 3, p. 368-389, 5 illus., 3 maps, 2 secs., July 1960, approx. 30 refs.

The Murrumbidgee riverine plains of southeastern Australia are prior formations, having been deposited by rivers no longer active. The last phases of prior-stream activity are shown by relic features at or just below the present surface. These relics indicate stream discharges very much greater than those of today's insignificant streams, while deep borings have revealed still older stream systems, also with high discharge.

The prior-Murrumbidgee river emerged from the foothills as a single stream and then on the plains broke into a complex distributary network. This gave rise to a flood plain with a lateral spread of 80 mi., extending nearly 200 mi. longitudinally from the debouchment and with a depth of hundreds of feet.

Meander belt analysis of the surface prior-stream relics has shown that at times of maximum flow some of the streams must have been immense.

Even today, spring thaw on the Australian Alps has a marked effect on the Murrumbidgee's flood incidence, and it is argued that during past cold periods, whether glaciations or not, increased snow melt must have given rise to much greater seasonal flooding.

3. STRUCTURAL GEOLOGY

See also: Geologic Maps 2-1940, 2-1947, 2-1948; Stratigraphy 2-2001; Geophysics 2-2038, 2-2042, 2-2076.

2-1994. Byers, A. Roddick. **DEFORMATION OF THE WHITEMUD AND EASTEND FORMATIONS NEAR CLAYBANK, SASKATCHEWAN:** Royal Soc. Canada, Trans., Sec. 4, Geol. Sci., v. 53, p. 1-11, 3 maps, sec., 1959, 22 refs.

Detailed mapping in the vicinity of Claybank, Saskatchewan, has shown that the Whitemud and the immediately overlying and underlying formations [all Upper Cretaceous] have been isoclinally folded and thrust faulted into a series of subparallel, overturned folds and thrust blocks. A study of aerial photographs indicates that this deformation of the Whitemud is not confined to the vicinity of Claybank but occurs throughout the area of the Dirt and Cactus hills. The structures are considered to have been produced by the subglacial drag of a Pleistocene ice sheet.--Auth.

2-1995. Fuchs, Alfred. **SOME STRUCTURAL PROPERTIES OF GREENLAND SNOW:** U.S. Snow, Ice & Permafrost Research Establishment, Research

Rept. 42, 24 p., 34 figs. incl. diags., graphs, Dec. 1959, 7 refs.

The results of petrofabric studies in the laboratory on 5 samples of high-density snow collected in 1954 and 1955 at depths of 8.0, 15.5, 23.0, 34.2, and 46.3 m. in a pit at Site 2 are reported. The porosity of the samples, the number of grains/cm.², the mean number of adjacent grains per grain, the mean grain cross section, the size distribution of grain cross sections, and the orientation of c-axes were determined from enlarged photomicrographs of thin sections, using reflected light and transmitted polarized light.

The number of adjacent grains per grain, the ratio of free to occupied grain surface, and the sphericity clearly depended on porosity and on each other. There was no strong relation between these data and the number of grains/cm.². Hence, the structure of high-density snow can be satisfactorily described by the porosity and the number of grains/cm.². Conclusions from a 2-dimensional thin section can be applied to a spatial sample only if the sample is isotropic by strata.--Auth. summ.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Geomorphology 2-1973, 2-1978, 2-1979, 2-1980; Geophysics 2-2047.

2-1996. Clark, Thomas H., and Colin W. Stearn. **THE GEOLOGICAL EVOLUTION OF NORTH AMERICA; A REGIONAL APPROACH TO HISTORICAL GEOLOGY:** 434 p., illus., maps, secs., diags., New York, Ronald Press, 1960, refs.

This historical geology of North America, designed for students with a prerequisite in physical geology, represents a new approach to teaching this subject. Historical development of the continent is presented in terms of its 3 major structural units: the bordering geosynclines, the stable interior, and the Canadian Shield. Emphasis is on recognition of both the similarities and important differences in the patterns of behavior of the various structural elements.

The book has 5 parts subdivided into 18 chapters. Sedimentation in the stable interior of North America is described immediately after the introductory chapters. To emphasize the evolutionary similarities between geosynclines, a chapter on the geosynclinal theory has been placed in Pt. 1 so that the student will gain an appreciation of the tectonic "woods" before Pts. 2 and 3 bring him to an examination of its "trees." After Mississippian time the sediments in the stable interior were largely influenced by source areas in and near the flanking geosynclines, and for this reason the later geologic history of the interior is developed in the chapters on these adjacent geo-

synclines.

In Pts. 2 and 3, the emphasis is shifted to a study of the Appalachian and Cordilleran geosynclines, from the beginnings in Precambrian time to the mountains of the present day. Similarities and differences in the development of these 2 geosynclines are stressed.

Following the presentation of the structure and sedimentary facies of the younger mountains of North America, the evolution of the Arctic Islands and the intricate geology of the Canadian Shield is dealt with in Pt. 4. The concepts presented on its orogenic history are largely those which have emerged within the last decade. A chapter on the great ice age concludes Pt. 4.

Emphasis throughout the book is on the influence of structural events, in source areas and in basins, on the accumulating sediments. Recurrent significant patterns in the distribution of sedimentary facies and examples of common associations of sedimentary rocks are described in detail. Facies maps are included, chiefly to illustrate the importance of patterns of sedimentary facies in interpreting geological history. Only those formation names which seem necessary for reference purposes or clarity are included, in order to emphasize an understanding of the principles of continental evolution and an ability to interpret facies patterns.

Four chapters on the life of the major divisions of geologic time are grouped together, as Pt. 5, in part to emphasize continuity of organic evolution. A classification of plants and animals stressing the

relationships of the organisms described in Pt. a short summary of the plant and animal kingdom, emphasizing those organisms having an adequate fossil record, have been appended to aid students with an insufficient background in the biological sciences.--From auth. pref.

7. Weiss, Malcolm P., and Carl E. Norman. AMERICAN UPPER ORDOVICIAN STANDARD DEVELOPMENT OF STRATIGRAPHIC CLASSIFICATION OF ORDOVICIAN ROCKS IN THE CINCINNATI REGION: Ohio, Div. Geol. Survey, Inf. no. 26, 14 p., chart (in pocket), 1960.

The development of the classification of the rocks of the Cincinnati region about Cincinnati, Ohio, is shown in their form. The successive columns of stratigraphic names that make up the chart have been correlated in order that the history of the nomenclature in the smallest stratigraphic units may be followed. The text accompanying the table supplements certain respects and includes an historical analysis of the stratigraphic unit called Madison or Cincinnati.--Auth.

8. Anderson, Sidney B. MISSISSIPPIAN FACILITIES: North Dakota Geol. Survey, Rept. no. 31, 9 p., 11 illus., Dec. 1958, 14 refs.

There has been considerable confusion in the correlations of the Madison group in the Williston basin, particularly in the Mission Canyon and Charles formations. This is due largely to the facies problem which exists in this part of the section. The Mission Canyon formation was originally described as massively bedded marine limestone, but the Charles formation was described as consisting largely of anhydrite, limestone and shale. The descriptions of the Charles indicate that it is really an evaporite sequence containing much salt and anhydrite. By following these descriptions it is found that the base of the Charles is stratigraphically higher to the E., while westward toward the center of the basin the base of the Charles is stratigraphically higher.

However, certain marker beds extend through the varying lithologies, and these marker beds are assumed to be time lines. To simplify the correlations of the upper Madison group it is proposed that the carbonate section be termed the Mission Canyon magnafacies and the evaporitic section be termed the Charles magnafacies.

The carbonate-evaporite facies boundaries provide several possibilities for stratigraphic traps.--Auth.

9. Jones, Charles L. THICKNESS, CHARACTER, AND STRUCTURE OF UPPER PERMIAN EVAPORITES IN PART OF EDDY COUNTY, NEW MEXICO: U.S. Geol. Survey, Trace Elements Memo. no. 1033, 19 p., map, sec. (in pocket), 3 tables (in pocket), Oct. 1959, 23 refs.

Between Project Gnome site and the International Minerals and Chemical Corporation's plant site, in the central eastern Eddy County, New Mexico, unconformably deposited deposits of Quaternary age and red beds of Tertiary age attain a thickness of about 700 ft., and unconformably on evaporites of late Permian age. The upper Permian evaporites are 3,000 to 4,000 ft. thick, and they are divided, in descending order, into the Rustler, Salado, and Castile formations. The Rustler is largely gypsum rock, the Salado is dominantly halite rock, and the Castile con-

tains both anhydrite rock and halite rock. The salt and anhydrite beds of the Salado and Castile are intruded by narrow dikes of alkalic rock along which the evaporites are little altered. The sedimentary rocks have a generally southeastward regional dip, but locally are warped in gentle folds of low amplitude and fairly small lateral dimensions.--Auth.

2-2000. Hansen, Dan E. NORTH DAKOTA HAS RAPID MESOZOIC FACIES CHANGES: North Dakota Geol. Survey, Rept. Inv. no. 34, 4 p., illus., 3 maps, 2 secs., 2 tables, Dec. 1959, 4 refs.; reprinted from World Oil, v. 149, no. 7, Dec. 1959.

Original paper was listed as GeoScience Abstracts 2-327.

2-2001. Brown, Randall E., and M.W. McConiga. SOME CONTRIBUTIONS TO THE STRATIGRAPHY AND INDICATED DEFORMATION OF THE RINGOLD FORMATION: Northwest Sci., v. 34, no. 2, p. 43-54, 2 illus., map, sec., table, May 1960, 13 refs.

The Ringold beds [Pleistocene?] dip westward, at angles less than 1°, at the type locality [along the E. bank of the Columbia River, western Franklin County, Washington]. Dip directions of Ringold beds in the Pasco basin generally parallel those of the underlying basalt and are radially inward toward the center of the Pasco basin or toward the axis of the Pasco syncline. This suggests that these variations from a horizontal attitude generally are not depositional dips. Deformation by differential compaction cannot be ruled out as a contributing factor; however, the parallelism of dip direction of Ringold sediments and the basalts, the general agreement in order of magnitude of angle of dip, the conformity of the conglomerate with the basalts in the Yakima River outcrop, and the dips of the "blue clays" up to 20° NE. question whether the roles played by deposition and compaction are more than locally significant. Evidence cited by Newcomb shows that the Ringold conglomerate was deposited by a southeastward flowing stream. Local westward to northwestward dips ("upstream") in that conglomerate, substantiated by comparable dips in higher and lower beds, indicate postdepositional warping.

Proof that type Ringold beds are not necessarily flat lying favors the acceptance that tilted Ringold-type beds, mapped by others in the surrounding area, are Ringold. The sedimentary sequence, traced across the Pasco basin, helps assure this.

The gradual general decrease in dips upward in the Ringold section favors essentially continuous deformation throughout the Pasco basin area during the period of deposition. This interpretation requires neither sudden cessation of the deformation that produced the latter part of the 2-stage impoundment of Newcomb nor deformation localized to the anticlinal ridges alone. Deformation, according to this interpretation, still could be continuing.--Auth. summ. & concl.

2-2002. Willis, E. H., Henrik Tauber, and K. O. Münich. VARIATIONS IN THE ATMOSPHERIC RADIOCARBON CONCENTRATION OVER THE PAST 1300 YEARS: Am. Jour. Sci., Radiocarbon Supp., v. 2, p. 1-4, graph, table, 1960, 9 refs.

Validity of the radiocarbon dating method has been the subject of considerable discussion in recent years. It has even been suggested that errors as

great as 800 years might arise between datings on the same sample made in different laboratories. The laboratories at Cambridge, Copenhagen, and Heidelberg have jointly undertaken a research project to extend present knowledge of variations in atmospheric radiocarbon and to serve as an exercise in inter-laboratory cross-checking. The subject of the experiment was a section of a sequoia tree (*Sequoia gigantea*). Samples were taken at 50-year ring intervals through the section by a half-inch drill, and each sample was subdivided into 3 parts, one going to each of the 3 laboratories. Since the radiocarbon uptake of only one tree was involved, possible variation due to geographic position was eliminated, and isotopic fractionation effects from sample to sample were reduced to a minimum. Results given are at present relative values only, but it seems unlikely that the broad conclusions reached will be materially affected by further research.

"The experiment has served to demonstrate that over the past 1, 200 years the fundamental assumptions of the radiocarbon dating method are empirically correct to about 1.5%. Whereas the implications of an error of this magnitude might be disturbing for very recent samples, with older samples the effect might be expected to be of little significance. It is to be noted also that, although check samples between laboratories on occasion produced results outside statistical expectation, such instances were few."--A. C. Sangree.

2-2003. McCallum, K. J., and W. Dyck. UNIVERSITY OF SASKATCHEWAN RADIOCARBON DATES II: *Am. Jour. Sci., Radiocarbon Supp.*, v. 2, p. 73-81, 1960, 28 refs.

List of radiocarbon dates obtained at the University of Saskatchewan since the last report was issued in 1955. The method used is essentially that of Suess, in which the sample is counted as acetylene gas. The proportional counter has a sensitive volume of 1 liter and is filled with acetylene to a pressure of 1 atm. Each sample is counted for at least two 20-hr. periods. The modern standards used were obtained from softwood logs grown in northern Saskatchewan and were either 50 or 100 years old as obtained from ring counts. All samples were treated with acid to remove carbonates. In addition, all samples in which there might have been the slightest danger of contamination by precipitation of younger humus were boiled with a 2% Na solution.--Auth. introd.

The 32 samples listed and described are mainly from central and western Canada. One sample is from Iceland.

2-2004. Hubbs, Carl L., George S. Bien, and Hans E. Suess. LA JOLLA NATURAL RADIOCARBON MEASUREMENTS: *Am. Jour. Sci., Radiocarbon Supp.*, v. 2, p. 197-223, 1960, 53 refs.

The recently established low-level radiation laboratory of Scripps Institution of Oceanography has been measuring radiocarbon since Aug. 1957. Through 1959 about 160 samples have been measured.

In the radiocarbon tests, the La Jolla laboratory staff utilizes the technique, with acetylene as the counting gas, that was developed at the U.S. Geological Survey. Until March 1959 only one set of equipment was in service, with a counter somewhat smaller than either of the 2 used in Washington, having a sensitive volume of approximately 0.6 liter.

In March 1959 an Oeschger-Houtermans counter, manufactured at the Physical Institute of the University of Bern, Switzerland, was installed. It operates with a background of less than 2.0 counts/min decreasing with filling pressure, and a sensitive volume of 1.3 liters. This counter proved to be more stable than the ordinary counters, and it can be operated at pressures as low as 440 mm., at which a background as low as 1.2 counts/min. can be attained. Therefore, this counter proves to be superior also in the measurement of relatively small samples. The installation of one or more additional counters is being considered, with the aim of increasing the annual output of tests.

Shell dates reported in this paper are calculated (as in U.S.G.S. I) from 19th century wood as a reference standard, without correction for any supposed fractionation of isotopes. This procedure has been adopted because in general, within the errors of measurement, the activity of 19th century wood corresponds to that of modern shell, despite the differences in the equilibrium distribution of the isotopes as shown by C^{13} analyses.--From auth. introd.

The 64 samples listed and described are mainly from the W. coast of the United States and Mexico. Two are from Australia.

2-2005. Crane, H. R., and James B. Griffin. UNIVERSITY OF MICHIGAN RADIOCARBON DATES V: *Am. Jour. Sci., Radiocarbon Supp.*, v. 2, p. 31-48, 1960, 53 refs.

A list of radiocarbon dates obtained since the preparation of Michigan list IV (GeoScience Abstracts 1-1680). The method of measurement and treatment of data are the same as described in the introduction to lists III and IV. The 102 samples listed and described are from the United States, Mexico, Easter Island, Japan, Sudan, and Spain.--A. C. Sangree.

2-2006. Bray, Ellis E., and W. H. Burke, Jr. SOCONY MOBIL RADIOCARBON DATES I: *Am. Jour. Sci., Radiocarbon Supp.*, v. 2, p. 97-111, 1960, 9 refs.

The samples in this list were measured by the methane proportional counter method reported by Burke and Meinschein. Shell samples were mechanically cleaned and washed with water. Where necessary, cold, very dilute HCl was used to remove the powdery exterior. Sedimentary wood and mud or clay samples were treated with hot concentrated HCl and washed with water before burning. Four other types of materials recovered from sediments were dated: 1) the total organic C, 2) benzene-soluble organic material, 3) foraminiferal tests, and 4) "dispersed carbonate." The foraminiferal samples were recovered from the sediment by washing on a 120-mesh screen. These were then converted to carbon dioxide by acid treatment. "Dispersed carbonate" was recovered in the form of CO_2 by acid (HCl) treatment of the sediment wash which had been depleted of Foraminifera. The total organic C samples were recovered by combustion to CO_2 after all carbonates had been removed by acid treatment. Organic extractables were also converted to CO_2 by combustion.

The errors given include contributions from the following sources: 1) Standard statistical counting error. 2) Background variation. This is taken as equal to the rms deviation from the mean of background determinations made during a period of time

ing well before and ending well after the
ng of the sample in question. 3) Variation in
ng rate of the modern standard. This is deter-
in the same way as 2). Not included are er-
ue to doubt about the half-life of C^{14} or the
ttness of our modern standard. The age cal-
ons are based on a C^{14} half-life of 5,568 years.
modern standard is hackberry wood grown about
This wood gives a counting rate which is
1.3% of the U.S. National Bureau of Stand-
xalic-acid standard.--Auth. introd.
e 126 samples listed are mainly from the United
(California, Gulf of Mexico, Wisconsin).
samples are from Quebec-Labrador.

7. Rubin, Meyer, and Corrinne Alexander. GEOLOGICAL SURVEY RADIOCARBON DATES
n. Jour. Sci., Radiocarbon Supp., v. 2, p.
35, 1960, 49 refs.

the dates listed herein have been determined at
S. Geological Survey radiocarbon laboratory
hington, D. C., since the last date list
(G. S. IV, 1958) and up to the end of 1959. A-
me continues to be the gas chosen. Each sample
for a period of 2 days in 2 separate counters
eparate electronics. The modern standard
s wood grown in the 19th century, and the ages
rrors have been computed in the same manner
ore. Pretreatment of wood, charcoal, and
amples by boiling in acid, alkali, and acid
is standard procedure.--Auth. introd.
e 322 samples listed and described are from
nited States, Canada, Greenland, Mexico,
mala, Ecuador, Colombia, France, Portugal,
any, Egypt, Kenya, Algeria, Lebanon, Turkey,
Australia, Indonesia, Pacific islands, and Ant-
a.

8. Stuiver, Minze, Edward S. Deevey, and
Gralenski. YALE NATURAL RADIOCARBON
UREMENTS V: Am. Jour. Sci., Radiocarbon
v. 2, p. 49-61, 1960, 57 refs.

list of dates measured since publication of Yale
eoScience Abstracts 1-1679) is given. The 39
es listed and described are from Canada,
ited States, Chile, U.S.S.R., Japan, Uganda,
o, Argentina, Kenya, and Southern Rhodesia.--
Sangree.

9. Barker, H., and C. J. Mackey. BRITISH
M NATURAL RADIOCARBON MEASURE-
MENTS II: Am. Jour. Sci., Radiocarbon Supp., v.
26-30, 1960, 18 refs.

the second series of radiocarbon measurements
at the British Museum Research Laboratory
reported in the following list. The equipment
ethod used remain the same as described in
first date list [GeoScience Abstracts 1-1681],
as stated there, the error terms are not based
y on counting statistics but are widened to in-
contributions of + 80 years for possible isotopic
onation effects and + 100 years for the de Vries
t. Ages are calculated on a half-life of $5568 \pm$
ars.--Auth. introd.

the 16 samples listed and described are from
a, British Honduras, Egypt, Great Britain,
Malaya, Thailand, Turkey, and Iraq.

10. Godwin, H., and E. H. Willis. CAM-
GE UNIVERSITY NATURAL RADIOCARBON

MEASUREMENTS II: Am. Jour. Sci., Radiocarbon
Supp., v. 2, p. 62-72, 1960, 16 refs.

The dates given were obtained during 1959. They
were made with carbon dioxide at 2 atm. pressure
in a proportional gas counter as described in the
first series (GeoScience Abstracts 1-1682). The 52
samples listed and described are primarily from
the British Isles. One sample is from France and 2
from Gough Island in the South Atlantic.--A. C.
Sangree.

2-2011. Tauber, Henrik. COPENHAGEN NATU-
RAL RADIOCARBON MEASUREMENTS III, COR-
RECTIONS TO RADIOCARBON DATES MADE WITH
THE SOLID CARBON TECHNIQUE: Am. Jour. Sci.,
Radiocarbon Supp., v. 2, 5-11, 1960, 34 refs.

In the Copenhagen I and II date lists, radiocarbon
dates for samples representing the late-glacial Al-
lerød oscillation and early Neolithic periods in
Switzerland and Denmark were given. At the time
of publication no account was taken of the dilution of
the atmosphere with inactive C by the extensive com-
bustion of fossil fuels since the Industrial Revolu-
tion and of its influence on the dating results. This
effect as measured by Suess amounted to 3.4% de-
pletion in wood samples from the heavily industri-
alized E. coast of the United States. Several later
measurements have shown that the magnitude of
this reduction in atmospheric C^{14} concentration
varies in different areas. The average universal de-
crease was calculated by Fergusson as $2.03 \pm .15\%$.
However, the magnitude of reported Suess effects
may vary with the chosen reference sample as a re-
sult of periodic changes (de Vries effect) in the at-
mospheric C^{14} concentration as found by de Vries.

The reduction of $2.5 \pm 0.5\%$ in the C^{14} concen-
tration of the former standards has made all dates
in the 2 date lists 200 + 40 years too young. Hence,
this number of years (200) should be added to all
dates in the 2 publications. After this correction
the dates may be considered as based on a contem-
porary value of 95% of the activity of the oxalic-acid
standard. Dates from the Copenhagen Laboratory
published later than Copenhagen I and II have been
corrected for Suess effect by the use of 19th century
wood as a reference standard, except for the dates
mentioned and corrected in section II of this paper.
--From auth. introd.

The samples listed and described are from Den-
mark, Switzerland, Alaska, Greenland, Iceland,
Italy, and The Netherlands.

2-2012. Tauber, Henrik, COPENHAGEN RADIO-
CARBON DATES IV: Am. Jour. Sci., Radiocarbon
Supp., v. 2, p. 12-25, 1960, 52 refs.

The list includes 59 samples from sites or sec-
tions described in archeologic or geologic publi-
cations. The samples are from The Netherlands,
Denmark, Greenland, Poland, Colombia, northern
Canada, Iceland, Germany, Syria, and the United
States.--A. C. Sangree.

2-2013. Nydal, R. TRONDHEIM NATURAL RA-
DIOCARBON MEASUREMENTS II: Am. Jour. Sci.,
Radiocarbon Supp., v. 2, p. 82-96, 1960, 33 refs.

A list of radiocarbon dates obtained from Sept.
1958 to Dec. 1959 and a few earlier dates omitted
from the first list (GeoScience Abstracts 1-1683).
As regards the geologic samples, the accordance

between the C^{14} age and the age predicted from geologic considerations is generally very good, and most of the discrepancies can be reconciled in favor of the C^{14} result.

Counter design, pretreatment, calculation, and fractionation analysis of C^{13}/C^{12} are described. The 62 samples listed are all from Norway.--A. C. Sangree.

2-2014. Östlund, H. Göte, and Lars G. Engstrand. STOCKHOLM NATURAL RADIOCARBON MEASUREMENTS III: *Am. Jour. Sci., Radiocarbon Supp.*, v. 2, p. 186-196, 1960, 16 refs.

This paper is a direct continuation of the second date list released from this laboratory [GeoScience Abstracts 1-1684], and the technique of preparation and the characteristics of our two 3-atm. carbon dioxide counters are substantially unchanged. As in previous lists, our standard is oak wood, grown A.D. 1845-1855 in Stockholm, corrected for radioactive decay to 1960. As usual, the counting rates have been corrected according to the mass-spectrometrically measured C^{13}/C^{12} ratio in each sample of purified carbon dioxide. In this scale the U.S. National Bureau of Standards Natural Radiocarbon Standard (NBS standard) gives a counting rate which is $104.5 \pm 0.4\%$ of our age-corrected oak standard. Taking into account that our oak has a C^{13}/C^{12} ratio

of 25 per mil lower than the Chicago PDB- C^{13} standard, our age figures can, by subtracting 55 years, be converted to the new, international radiocarbon age scale proposed by Broecker and Olson.

In each error are included the statistical uncertainties of the measurements of the sample and related standard and background figures, together with the small error in the half-life of radiocarbon, the latter assumed to be 5568 ± 30 years. The variation of the C^{14} activity of the biosphere during past time as reported by de Vries, has not been taken into account.--Auth. introd.

The 90 samples listed are mainly from Sweden. Four samples are from Cyprus, 2 from the Adriatic Sea.

2-2015. Olsson, Ingrid. UPPSALA NATURAL RADIOCARBON MEASUREMENTS II: *Am. Jour. Sci., Radiocarbon Supp.*, v. 2, p. 112-128, 1960, 33 refs.

This list covers the samples measured at the Uppsala radiocarbon laboratory during 1959. Uppsala I was listed as GeoScience Abstracts 1-1685. The 105 samples listed and described are from the Mediterranean area, Iceland, Svalbard, Norway, Sweden, United States, Argentina, Peru, and Austria.--A. C. Sangree.

5. PALEONTOLOGY

See also: Areal and Regional Geology 2-1967.

2-2016. Brown, William B. FOSSILS IN DAILY LIFE: *Frontiers*, v. 24, no. 4, p. 117-119, 128, 2 illus., Apr. 1960.

Micropaleontologists use foraminifers and ostracodes to help correlate rocks in oil and water wells. Pleistocene oysters and clams have been used to pave roads and in making fertilizers. Diatoms are used in making scouring material and insulation. Collecting and selling specimens to schools and institutions is a commercial activity. Limestone consisting essentially of fossils is used as a construction material. Half of the world's supply of commercial ivory is fossil. Coal, oil, and peat are fuels derived from fossils.--M. Russell.

2-2017. Cramer, Howard Ross. DARWIN'S EFFECT ON PALEONTOLOGY: *Georgia Acad. Sci., Bull.*, v. 17, no. 4, p. 171-174, Sept. 1959.

Darwin's implied use of paleontology as proof of a theory which had been developed primarily on biological observations was to cause that theory to be used prematurely in paleontology. Modern paleontology is based in part on hypotheses derived primarily from observations of fossils and geology. Had paleontology been used and kept at the observation level, much of the present undoing of traditional paleontology would not have to be done.--M. Russell.

2-2018. Wagner, Frances J.E. PALAEOECOLOGY OF THE MARINE PLEISTOCENE FAUNAS OF SOUTHWESTERN BRITISH COLUMBIA: *Canada, Geol. Survey, Bull.* 52, 67 p., pl., map (in pocket), diag., graph, 20 tables (2 in pocket), 1959, 192 refs.; abs. in English and French.

The report is based on studies in the lower Fraser

Valley region and in the Qualicum-Alberni area of Vancouver Island. In it are listed all marine species from Pleistocene and Recent deposits identified by the writer, together with those listed in earlier publications. All lived within a period dating back to about 25,000 years before the present.

It is concluded that the water temperature for the oldest Pleistocene faunas was comparable to the present temperature of Bering Sea, and for the younger Pleistocene faunas to that of northern Gulf of Alaska. Early Recent faunas indicate a somewhat warmer temperature. Warming of the sea apparently lagged slightly behind that of the land. All forms lived in shallow water, 20 fathoms or less, in bays or estuaries.--Auth.

2-2019. Nelson, Samuel J. EVOLUTION OF THE MISSISSIPPIAN LITHOSTROTION MUTABILE. LITHOSTROTION WHITNEYI CORAL GROUP OF THE SOUTHERN CANADIAN ROCKIES: *Royal Soc. Canada, Trans., Sec. 4, Geol. Sci.*, v. 53, p. 21-26, 2 figs., 1959, 13 refs.

The evolutionary history of the Mississippian fasciculate corals *Lithostrotion mutabile* (Kelly), *L. n. sp.*, *L. whitneyi* Meek, and *L. arizelum* (Crickmay) is suggested. Usually, evolution of the group has been towards increase in corallite size, accompanied by increase in number and length of major septa, also accompanied by increase in tabular inclination, number of dissepiments, and width of dissepimentarium. Longitudinal patterns of structures of juvenile corallites of one horizon usually mimic structures of species of the preceding horizon.--Auth.

2-2020. Warren, P. S., and C. R. Stelck. EVOLUTIONARY TRENDS WITHIN GASTROPLITAN AMMONOIDS: *Royal Soc. Canada, Trans., Sec. 4,*

eol. Sci., v. 53, p. 13-20, illus., 1959, 16 refs.

Middle Albian *Gastrolites* descended from cosmopolitan *Beudanticeras*-like ammonites (*Cleoniceras*) and developed local genera such as the upper Albian *Neogastrolites* and the lower Cenomanian *enicocheras*. Relationships are postulated with allied genera such as *Lemuroceras*, *Subarctoplites*, *reboidiceras*, *Tetrahoplites*, *Metasigaloceras*, and some members of the *Acanthoceratidae*. Extreme pliability within *Gastrolite* morphology permitted adaptation throughout varying paleoecological regimes.--Auth.

2-2021. Rice, H. M. A. FOSSIL BIBIONIDAE (DIPTERA) FROM BRITISH COLUMBIA: Canada, Geol. Survey, Bull. 55, 37 p., 4 pls., 8 figs. incl. illus., map, 3 tables, 1959, 15 refs.; abs. in English and French.

Tertiary *Bibionidae* belonging to the genera *Penetria* and *Plectia* in the collections of the Geological Survey of Canada are described and figured. In all, 11 specimens are illustrated belonging to 21 species. Fifteen of the species were previously described by Handlirsch and Scudder. These have been refigured and redescribed, and to some extent regrouped, as additional intergrading specimens have shown that some forms believed to be of distinct species are in reality members of a single species.

The wing of every specimen has been drawn, and many measurements are listed.--Auth.

2-2022. Eaton, Theodore H., Jr., and Peggy Lou Stewart. A NEW ORDER OF FISHLIKE AMPHIBIA FROM THE PENNSYLVANIAN OF KANSAS: Kansas, Univ., Mus. Nat. History, Pubs., v. 12, no. 4, p. 19-240, 12 illus., 2 tables, May 1960, 11 refs.

Hesperoherpeton garnettense Peabody, based on a capulocoracoid and part of a vertebra, was originally placed in the order *Anthracosauria*, suborder *Emolomeri*, family *Cricotidae*. A new skeleton from the type locality near Garnett, Kansas (Rock Lake shale, Stanton formation, Upper Pennsylvanian), shows that the animal has the following rhipidistian characters: large notochordal canal below foramen magnum, otico-occipital block separate from ethmosphenoid, postaxial processes on 3 axial bones of forelimb, pectoral girdle (probably) articulated with tabular. Nevertheless, *Hesperoherpeton* has short digits, an anthracosaurian type of pectoral girdle, an otic rather than spiracular notch, nostrils separate from the mouth, and vertebrae in which the intercentrum is U-shaped and the pleurocentra large but paired. The stapes reaches the quadrate.

Hesperoherpeton is placed in a new order, *Plesiosopoda*, on the basis of the characters stated above, and a new family, *Hesperoherpetonidae*. Specialized characters of the family include: reduction of circumorbital bones, bringing the squamosal to the edge of the orbit, loss of certain bones of the temporal region, and relative enlargement of the orbits and foramen magnum, in correlation with the diminutive size of the animal. The structural characters of *Hesperoherpeton* suggest to us that it lived in the shallow, weedy margins of lagoons, rested with its head partly out of water, and normally did not walk on land.--Auth. summ.

2-2023. Brady, L. F. DINOSAUR TRACKS FROM THE NAVAJO AND WINGATE SANDSTONES: Plateau, v. 32, no. 4, p. 81-82, Apr. 1960.

Dinosaur tracks from 3 Navajo sandstone (Jurassic) and 1 Wingate sandstone (Triassic) outcrops are of particular interest because of the rarity of fossils in these formations. One set of tracks from the Kaibeto plateau is possibly *Segisaurus*; another is apparently of a bipedal dinosaur which used its forelegs in climbing a steep slope.--M. Russell.

2-2024. Langston, Wann, Jr. ANCHICERATOPS FROM THE OLDMAN FORMATION OF ALBERTA: Canada, Natl. Mus., Nat. History Paper no. 3, 11 p., illus., diag., Sept. 1959, 13 refs.

Anchiceratops is reported from the Upper Cretaceous Oldman formation of southern Alberta; its geologic range is thus extended downward. Analysis of *Anchiceratops* occurrences shows that these are practically confined to sedimentary deposits where other ceratopsians are uncommon. A correlation exists between them and dark-colored, noncoaly, fine-grained sediments deposited near the strand in regions of low relief. In life, *Anchiceratops* seems to have been a relatively stenopic dinosaur inhabiting low-lying, possibly swampy, situations not particularly suitable to related ceratopsians.

Sometimes reference to *Anchiceratops* in the context of an "index" to the Edmonton formation violates biostratigraphic principles, but *Anchiceratops* remains are apparently restricted to sediments of the lower Edmonton facies of appropriate age within a restricted paleogeographic realm.--Auth.

2-2025. Ray, Clayton E. TRICHECODON HUXLEYI (MAMMALIA: ODOBENIDAE) IN THE PLEISTOCENE OF SOUTHEASTERN UNITED STATES: Harvard Univ., Mus. Comp. Zoology, Bull., v. 122, no. 3, p. 129-142, 2 illus., secs., March 1960, 34 refs.

A complete discussion and description of a Pleistocene walrus tusk from Florida is presented. The tusk is compared with *Odobenus rosmarus* (living walrus) and with *Trichecodon huxleyi* from the Pleistocene of Europe. An earlier reported find from South Carolina is also compared. The Florida and South Carolina tusks are assigned to the extinct, *Trichecodon huxleyi*, although they cannot be completely excluded from the recent genus, *Odobenus*.

The presence of *T. huxleyi* in the southeastern United States suggests that it was an inhabitant of warmer waters than is the living walrus. It is suggested that the range of *T. huxleyi* ranged to the south of *O. rosmarus* on either side of the Atlantic.--J.J. Stephens.

2-2026. Taylor, Philip S. A REPORT ON FOSSIL BISON FROM A PEAT BOG IN ST. PAUL, MINNESOTA: Minnesota Acad. Sci., Proc., v. 25/26, p. 200-203, 1957/1958, pub. 1960, ref.

Three skulls and a scapula of *Bison occidentalis* were recovered by dragline from a thin marl layer in peat of an ancient glacial river channel. Size and shape of the horn cores and skull measurements distinguish the fossils from modern *Bison bison*, remains of which occur in profusion at the site.--M. Russell.

2-2027. Cridland, Arthur. FRAGMENTARY REMAINS OF A LYCOPOD FROM THE DESMOINESIAN SERIES (PENNSYLVANIAN) OF SOUTHEASTERN KANSAS: Kansas, Univ., Sci. Bull., v. 40, no. 1,

p. 3-19, 25 figs. incl. illus., secs., Apr. 1960, 7 refs.

Lepidodendron moorei sp. nov. is described from 6 specimens found in Kansas coal balls. The assignment of this lycopod to *Lepidodendron* is arbitrary as there are no leaf bases on any of the specimens. --Auth.

2-2028. Chaney, Ralph W., and Daniel I. Axelrod. MIOCENE FLORAS OF THE COLUMBIA PLATEAU. PART I. COMPOSITION AND INTERPRETATION, by Ralph W. Chaney; PART II. SYSTEMATIC CONSIDERATIONS, by Ralph W. Chaney and Daniel I. Axelrod: Carnegie Inst. Washington, Pub. 617, 237 p., 44 pls., 32 tables, 1959, 189 refs.

The lowlands of the Columbia Plateau during Miocene time, their drainage deranged by flows and pyroclastics from adjacent volcanoes and by the rising Cascade Range to the W., were widely occupied by a forest in which *Taxodium dubium* was the dominant tree. The Mascall flora of the John Day basin represents this swamp forest. Some valleys, apparently better drained, provided a suitable habitat for *Glyptostrobus oregonensis*. The flora from the Stinking Water basin occupied such a valley. Deciduous hardwood associates of these conifers were predominantly temperate, resembling more closely members of the modern swamp cypress forest of the southeastern United States than of the water pine forest on the coast of S. China. In earlier Tertiary floras *Taxodium* and *Glyptostrobus* were commonly associated with broad-leaved evergreens of subtropical types. Present-day restriction of these conifers southward suggests that lowering temperature may have been a major factor in their extinction in western North America near the close of the Miocene, with reduced summer rainfall also determinative.

Most fossil floras of any age are largely representative of lowland vegetation, for the entrance of leaves, fruits, and stems into the sedimentary record is controlled by the distance of plants from sites of deposition, which are commonly near sea level. Counts of specimen frequency in our large collections make possible recognition of upland components in the predominantly lowland Mascall and Stinking Water floras; their numerical representation is scant and in some species is limited to winged fruits or seeds, as might be expected if they were transported from a distant habitat. Modern equivalents of these plants occupy slopes adjacent to valley lowlands. Confirming such inferences of upland forests is the Blue Mountains flora, from which typical species of the lowlands are absent; its abundant trees are of upland types, many of which are meagerly represented in the Mascall and Stinking Water floras.

These 3 Miocene floras, living within a distance of 50 mi. at approximately the same time, include many of the same dominant species; their distinctive members are interpreted as indicating local differences of environment. Four other floras from adjacent areas, the Payette, Succor Creek, Trout Creek, and Upper Cedarville, also show marked resemblance in composition. All 7 of these floras are considered to have lived in middle Miocene time and into the upper Miocene, on the basis of their stratigraphic occurrence and stage of floristic development. The Latah flora from Washington and Idaho, with fewer Mascall dominants and a larger group of warm-temperate species, appears to be referable to a lower level in the middle Miocene.

The Thorn Creek and Lower Idaho floras from western Idaho, and the Lower Ellensburg from cen-

tral Washington, are similar to this group of middle-upper Miocene floras but differ in lower representation of summer-wet members, a great reduction in lowland conifers and generally smaller leaves; their age is near the end of the Miocene. Up to that time the Cascade Range at the W. appears to have been so low that it did not intercept the summer rains required by many members of the Arcto-Tertiary Geoflora. Continuing rise of this barrier brought reduced precipitation and greater temperature extremes to the Columbia Plateau, and many genera disappeared during Pliocene time. All these former residents of western America have survived on the eastern side of Asia or North America, where climate and topography like that of the middle Tertiary have persisted with less change down to the present. --Auth. concl.

2-2029. Gutjahr, C.C.M. THE HISTORY AND APPLICATION OF PALYNOLOGY (POLLEN AND SPORES): Houston Geol. Soc., Bull., v. 2, no. 7, p. [16-20], March 1960, ref.

The recognition by man of the role of pollen can be traced back as far as the early Assyrians who hand-pollinated date palms. Detailed study of pollen became possible only with the invention of the microscope. Stratigraphic correlation by pollen analysis is useful in terrestrial or brackish-water deposits. Taxonomic distinctions are good, and chances for preservation are good in a reducing environment. Transportation is accomplished by wind, water, and animals. Ten glacial and Holocene zones are recognized in western Europe on the basis of pollen analysis.--M. Russell.

2-2030. Kremp, G.O.W., H. T. Ames, and A. J. Kovar. CATALOG OF FOSSIL SPORES AND POLLEN. VOLUME 11. DEVONIAN SPORES: 157 p., illus., University Park, Pennsylvania, Pennsylvania State University, College of Mineral Industries, Dept. of Geology, Palynological Laboratories, 1960, refs.

Since sufficient space is not available in a single volume of the Catalog to permit inclusion of the 297 new taxa described by S. N. Naumova from the Devonian of Russia (*Spore-Pollen Complexes of the Upper Devonian of the Russian Platform and Their Significance for Stratigraphy*, 1953), 2 volumes have been assigned to the presentation of these data. Vol. 11 contains 150 specific or subspecific taxa; the remaining 147 descriptions will appear in Vol. 12.

Vol. 11 includes specific and subspecific taxa assigned to the following genera: *Acanthotriletes*, *Archaeoperisaccus*, *Archeotriletes*, *Archaeozonotriletes*, *Azonomonoletes*, *Brochotriletes*, *Camarozonotriletes*, *Chomotriletes*, *Dictyotriletes*, and *Hymenozonotriletes*. All descriptions of important types (e.g. holotypes and paratypes) assigned to a single taxon are presented.--From introd.

2-2031. Felix, Charles J. SOME NEGLECTED ASPECTS OF PLANT MICROFOSSIL RESEARCH: Ohio Jour. Sci., v. 60, no. 2, p. 88-93, March 1960.

Present plant microfossil classification systems frequently disregard demonstrated relationships between spores and parent fructifications. *Planisporites*, *Lycospora*, and *Calamospora* are examples of Paleozoic spore genera whose botanical affinities have been investigated and illustrate the value of megafossil and microfossil research. Many current taxonomic problems may be solved if the botanical

spect of plant microfossil research is considered.--uth.

-2032. Fenton, Carroll Lane. **WILDLIFE THROUGH ARIZONA'S AGES**: Arizona Highways, 36, no. 3, p. 32-35, illus., March 1960.

6. GEOPHYSICS

See also: Geologic Maps 2-1923 through 2-1934, 2-1944; Engineering Geology 2-2172.

-2033. Dobrin, Milton B. **INTRODUCTION TO GEOPHYSICAL PROSPECTING**: 2d ed., 446 p., illus., secs., diags., graphs, tables, New York, McGraw-Hill Book Company, 1960, refs.

This second edition presents the principles and techniques of geophysical prospecting for oil and minerals. It covers the major methods of geophysical prospecting and discusses the physical principles, instruments, field techniques, reduction of data, interpretation, and examples showing results of surveys. It is a textbook intended primarily for geology and mining majors who expect to enter the field of petroleum or mineral exploration, and secondarily for practicing geophysicists, geologists, and mining engineers who need a resumé in nonmathematical form of recent advances in various geophysical techniques outside their own particular field of specialization. The more involved mathematical derivations have been replaced by verbal descriptions of the physical phenomena involved, so that no mathematics beyond trigonometry is required to follow the text.--L. Russell.

Contents:
Introduction.
Seismic wave propagation.
Earthquakes and the structure of the earth.
Seismic instruments and seismic surveys.
Seismic refraction method.
Seismic reflection method.
Interpretation and geologic coordination of reflection data.
Fundamental principles of gravity prospecting.
Earth's gravity and the concept of isostasy.
Instruments for measuring gravity.
Gravity field measurements and reductions.
Interpretation of gravity data.
Magnetic prospecting: fundamental principles and instruments.
Magnetism of the earth.
Magnetic measurements on land and interpretation of vertical-field data.
Prospecting with the airborne magnetometer.
Electrical prospecting methods.
Prospecting for radioactive minerals.
Integration of geophysical methods as illustrated by case histories.

-2034. Gutenberg, Beno. **PHYSICS OF THE EARTH'S INTERIOR**: 240 p., maps, secs., diags., graphs, tables, New York, Academic Press, 1959, refs.

The interior of the earth as revealed by geophysical investigations is reviewed. The chapters deal successively with fundamental problems and fundamental data; the structure of the earth; the earth's crust; the mantle of the earth; the core; temperature

and thermal processes in the earth; density, pressure, gravity, and flattening in the earth; and elastic constants and elastic processes in the earth. Unsolved problems are pointed out along with results of a more positive nature.--J.W. Clarke.

Contents:

Fundamental Problems and Fundamental Data
Methods of Investigating the Earth's Interior, and the Accuracy of the Results
The Figure of the Earth and Related Constants
Gravity at Sea Level
Astronomical Data
The Structure of the Earth
Historical Review
The Boundaries of the Major Units of the Earth
Causes for Discontinuities in the Earth
The Earth's Crust
Definitions
Methods of Determining Velocities in Layers and Their Thickness
Velocities in Crustal Layers and Depths of Discontinuities Based on Observation of Elastic Waves
Effects of the Crust on Amplitudes of Reflected Waves PP
Conclusions from Channel Waves and Microseisms
Conclusions from Dispersion and Extinction of Surface Waves
Gravity Anomalies and the Structure of the Earth's Crust
Results Based on Several Methods
The "Roots of Mountains"
The "Boundary" of the Pacific Basin; the "Andesite Line"
The Earthquake Belts
Transition from Oceanic to Continental Crust
Disturbance of Isostasy by Removal or Addition of Loads at the Surface
Causes for Discontinuities in the Crust
The Mantle of the Earth
Subdivisions of the Mantle
Region B from the Mohorovičić Discontinuity to about 200 km. Depth. The "20°-Discontinuity"
Region C between about 200 and 950 km. Depth
The Mantle between a Depth of about 950 km. and the Core Boundary (Region D)
The Core
General Discussion of Travel Times through the Core, and of the Resulting Wave Velocities
The Outer Core (Region E)
The Transition Zone in the Core (Region F)
The Inner Core (Region G)
State and Composition of the Core
The Earth's Magnetic Field and the Core
Temperature and Thermal Processes in the Earth
Temperature and Temperature Gradients at the Earth's Surface
Temperature at the Surface

Periodic Variations of the Temperature in the Uppermost Portion of the Crust
 Thermal Gradients in Continents
 Thermal Gradients in Ocean Bottoms
 Thermal Conductivity in the Earth
 Thermal Conductivity in the Crust
 "Thermal Conductivity" in the Mantle
 Thermal Conductivity in the Core
 Heat Flow through the Earth's Surface
 Heat Emitted by Volcanoes and Heat Generated by Earthquake Waves
 Generation of Heat in the Earth
 The Melting Points of Materials in the Earth
 Calculated Temperature Changes in the Earth during its History
 Estimated Temperatures in the Earth
 Possibility of Molten Portions in the Upper Mantle; Roots of Volcanoes
 Density, Pressure, Gravity, and Flattening in the Earth
 The Mean Density of the Earth
 Equations Used in the Determination of the Density in the Earth as a Function of Depth
 Assumed Continuous Density-Depth Curves
 Density-Depth Curves Assuming Straight Lines Separated by Discontinuities
 Density-Depth Curves on the Assumption that the Earth Consists of Homogeneous Shells
 General Results Related to the Problems of the Density in the Earth
 The Change in Density at the Core Boundary
 Density of Materials under High Pressure
 Estimated Densities in the Earth
 Gravity in the Earth
 The Pressure in the Earth
 Flattening of Near-Equipotential Ellipsoidal Surfaces in the Earth
 Elastic Constants and Elastic Processes in the Earth
 Elastic Constants and Love's Numbers
 The Earth's Free Nutation. Latitude Variations
 Tides of the Solid Earth
 Free Vibrations of the Earth
 Numerical Values of Love's Numbers
 The Rigidity in the Earth
 The Bulk Modulus in the Earth
 Poisson's Ratio in the Earth
 Young's Modulus and Lamé's Constant λ in the Earth
 Nonelastic Processes in the Earth
 Theoretical Treatment of Nonelastic Processes in the Earth
 Attenuation of Elastic Waves in the Earth
 The Strength Resisting Flow Processes (Yield Point)
 "Viscosity" of the Earth's Outer Layers. Post-glacial Uplift
 Flow in the Deep Portions of the Earth
 Strain-Rebound Characteristics of Earthquake Series and Aftershocks
 Convection Currents in the Earth
 Movements of Large Crustal Blocks Relative to Each Other
 Secular Movements of the Poles
 Movements of the Poles of Rotation
 Movements of the Magnetic Poles Relative to the continents.

A popular account of some scientific aspects of the earth and sun, in special connection with the 1957-1958 International Geophysical Year. It contains 7 sections as follows: 1) earth and oceans, 2) solid and liquid earth, 3) atmosphere, 4) ionosphere, 5) cosmic rays, the sun, and nuclear radiation, 6) growth of natural science, and 7) International Geophysical Year. The status of knowledge in the various fields of interest is reviewed, and needs for additional information, to which the efforts of the 67 IGY nations were directed, are set forth. During the IGY, particular emphasis was given to collecting data on the upper atmosphere, aurora, airglow, earth's magnetism, and transient magnetic variations. In earth studies the IGY participants concentrated their efforts in making seismic measurements, collecting data on the earth glaciers and ice caps, and in oceanographic studies.--M. Russell.

2-2036. Klushin, I.G. THE SEPARATION OF GEOPHYSICAL ANOMALIES THAT ARE LESS THAN THE MEAN SQUARE ERROR OF THE MEASUREMENTS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 2, p. 123-127, 6 figs., pub. May 1960, 6 refs.

Certain questions concerning the accuracy of geophysical observations are discussed as well as the question of the possibility of distinguishing specific characteristics of geophysical fields in the presence of disturbances. The errors that are related to the method of measurement and processing of observations are analyzed. The accuracy of geophysical observations is measured by the root mean square value of the errors of measurement. Using the method of observational calculus, Klushin arrives at the following conclusions: if the measurements are made at separate points and the errors have a random character, then it is possible to reduce the absolute value of these errors substantially by means of filtering. To separate with full assurance the anomalies that have amplitudes smaller than the mean square value of the errors of the measurements, a sufficiently dense network of observations is necessary to provide a difference between the spectral representation of the anomaly and the error. The question whether it is necessary to make a greater number of observations in comparison with the existing norms, can be solved only on the basis of an analysis of a given geophysical problem. There are cases when such an increase would be superfluous.--S. T. Vesselowsky (courtesy Geophysical Abstracts 178-192).

2-2037. National Academy of Sciences-National Research Council, Space Science Board. SCIENCE IN SPACE. CHAPTER III. THE EARTH. Edited by Harrison Brown: 36 p., Washington, D. C., 1960, 70 refs.

Chap. 3 of a report prepared for the purpose of 1) reviewing areas and opportunities for important research studies using space vehicles, and 2) to suggest what now appear to be major areas of emphasis for the national space effort. This chapter discusses the potentialities which the coming of artificial satellites has opened for the scientific investigation of the Earth's solid body (geodesy), its lower atmosphere (meteorology), and upper atmosphere.--M. Russell.

2-2035. Chapman, Sydney. IGY: YEAR OF DISCOVERY. THE STORY OF THE INTERNATIONAL GEOPHYSICAL YEAR: 112 p., illus., maps, diagrs., graphs, Ann Arbor, University of Michigan Press, 1959.

2-2038. Carey, S. Warren. THE STRENGTH OF THE EARTH'S CRUST: New York Acad. Sci., Trans.,

22, no. 5, p. 303-312, 4 maps, March 1960, 16 fs.

Large negative anomalies in Quebec presumably due to orogenic roots of Precambrian age, a N.-S. symmetry of the geoid deduced from satellite-orbit calculations, and deductions from measurements of permanent magnetism of the Bushveld lopolith have all been cited as indicating a very strong and ad-resistant crust. It is shown that this conclusion is not necessarily follow from the available data and that alternative hypotheses fully consistent with concepts of isostatic adjustment would explain the findings. The Quebec anomalies are consistent with assumed effects of Pleistocene ice loading, variations in the sub-mantle would affect satellite orbits, and alternative theories of structural development could account for the Bushveld findings.--M. Russell.

2039. Kazinsky, V.A. INTERPOLATION POLYNOMIALS APPLIED TO THE STUDY OF THE EARTH'S FIGURE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 2, p. 199-200, 1 fig., table, pub. May 1960.

The use of polynomials in the interpolation of different formulas or numerical tables is useful in geophysics. Kazinsky discusses the use of interpolation polynomials in computations of the earth's figure. He starts with Stokes' formula for the deviation of the geoid from the spheroid. The expression is developed into an interpolation formula using Lamert's table. Similarly, an interpolation formula can be constructed for the approximate computation of limb-line deviation, using Vening Meinesz formulas. S.T. Vesselowsky (courtesy Geophysical Abstracts 7-172).

2040. National Academy of Sciences-National Research Council, Space Science Board. SCIENCE IN SPACE. CHAPTER II. THE NATURE OF GRAVITATION, by R.H. Dicke: 21 p., graph, Washington, D.C., 1960, 27 refs.

Chap. 2 of a report prepared for the purpose of reviewing areas and opportunities for important research using space vehicles and 2) to suggest what may appear to be major areas of emphasis for the national space effort. The areas of consideration include the following, taken from a listing of the major headings in the report: basic considerations; the classic checks (of general relativity); possible future developments; implications of a varying gravitational constant; proposals for satellite research in gravitation.--M. Russell.

2041. Fedynsky, V.V. POSSIBILITIES OF DEVELOPING AN APPARATUS FOR MAKING GRAVIMETRIC MEASUREMENTS WHILE IN MOTION: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 1, p. 93-97, 6 figs., pub. May 1960, 16 refs.

The article deals with the introduction of airborne gravity surveying as a new branch of exploratory geophysics. High precision is necessary; even steeply dipping salt domes produce a gravity anomaly of only 1 to 30 mgal., and in most cases the anomalies over oil and gas deposits reach only a few milligals and over ore deposits only fractions of a milligal. Such precision in an airplane is not possible with present gravity instruments. It is important to note that the speed of the airplane creates new difficulties, pro-

duced by the Eötvös effect resulting from the difference in centrifugal acceleration between the rotating earth and the moving observer, an effect which can amount to as much as 1,500 mgal. The time of a reading therefore must be exceedingly short.

Fedynsky finds promise in Balabushevich's suggestion to measure the second derivative of gravity, especially the quantity V_{zz} , using Joly's method with an additional attachment suggested by Schmerwitz. In this form, built as a double vertical balance and made astatic, the instrument seems to be capable of attaining the necessary precision and sensitivity, but so far only as an immovable laboratory instrument. Another type of vertical gravity gradientmeter can be built as a combination of 2 vertical gravimeters in one housing. By making it astatic, it will be possible to attain the necessary precision. It will also be less sensitive to airplane jerks. In any case much experimental work will be necessary to adapt any of these instruments to airborne measurements.--S.T. Vesselowsky, (courtesy Geophysical Abstracts).

2-2042. Timofeev, A.N., and O.V. Bellavin. GRAVIMETRIC AND MAGNETO-METRIC TRAVERSES OF THE TAGIL-MAGNITOGORSK URAL SYNCLINORIUM: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 2, p. 207-209, 2 figs., table, pub. May 1960, 2 refs.

The anomalies of the vertical component of the magnetic field in a surface survey under the condition that there are outcrops of deep-seated rocks reflect the degree of extension of magnetic rocks in the horizons closest to the surface. Therefore they have a restricted value in studying the plutonic geological structure.

The Tagil-Magnitogorsk synclinorium is characterized by a large positive gravity anomaly in Bouguer's reduction. Gravimetric determinations have clarified the local gravity anomalies, reflecting the geological structure of the synclinorium. The most distinct local anomalies within the limits of the synclinorium are caused by intrusive rocks of the western and eastern belts of gabbro-peridotite, coming out on to the surface of the earth. Local gravity anomalies under conditions in which the disturbing rocks come out on to the ground surface create the possibility for determining certain elements of the occurrence of the geological structures and the constructing of sections of the distribution of anomalous masses up to the zone of complete gravitational compensation. Gravimetric studies under the conditions indicated thus enable us to study the plutonic geological structure of the Urals. Extrapolation of the structures and the structural-tectonic zones from the limits of the exposed part of the Urals to the covered parts is especially positive. It seems possible that even deeper layers of the earth's crust could be studied.--Auth. concl.

2-2043. Pertsev, B.P., N.N. Pariisky, and M.V. Kramer. COMPARISON OF VARIOUS METHODS OF THE HARMONIC ANALYSIS OF THE TIDAL DEFORMATIONS OF THE EARTH: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 2, p. 159-160, table, pub. May 1960, 4 refs.

A comparison of 4 methods of the harmonic analysis of elastic tides. It was made by analyzing the theoretical values of the tide-generating potential; the results of the comparison show that with respect to the amount of work involved, all 4 methods are

approximately equivalent. Regarding the degree of accuracy of the attained results, however, Pertsev's method has a slight advantage.--Auth.

2-2044. Strakhov, V.N. THEORY OF THE TWO-DIMENSIONAL PROBLEM OF MAGNETIC PROSPECTING: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 2, p. 161-165, pub. May 1960, 13 refs.

Theoretical magnetometry deals with 2 classes of problems, the direct and the inverse. The most convenient mathematical method for the interpretation of 2-dimensional magnetic anomalies (the inverse problem) is the theory of functions of complex variables. Strakhov develops the fundamental relations of the theory of the magnetic field, introducing the concept of the complex potential of the magnetized body, the effective complex field intensity, and the components of the vector of the effective field strength.--S.T. Vesselowsky (courtesy Geophysical Abstracts 177-307).

2-2045. Henderson, Roland G. A COMPREHENSIVE SYSTEM OF AUTOMATIC COMPUTATION IN MAGNETIC AND GRAVITY INTERPRETATION: Geophysics, v. 25, no. 3, p. 569-585, 7 figs. incl. 3 maps, graphs, June 1960, 16 refs.

In the interpretation of magnetic and gravity anomalies, downward continuation of fields and calculation of first and second vertical derivatives of fields have been recognized as effective means for bringing into focus the latent diagnostic features of the data. A comprehensive system has been devised for the calculation of any or all of these derived fields on modern electronic digital computing equipment. The integral for analytic continuation above the plane is used with a Lagrange extrapolation polynomial to derive a general determinantal expression from which the field at depth and the various derivatives on the surface and at depth can be obtained. It is shown that the general formula includes as special cases some of the formulas appearing in the literature. The process involves a "once for all depths" summing of grid values on a system of concentric circles about each point, followed by application of the appropriate one or more of the 19 sets of coefficients derived for the purpose. Theoretical and observed multilevel data are used to illustrate the processes and to discuss the errors. The coefficients can be used for less extensive computations on a desk calculator.--Auth.

2-2046. Steenland, Nelson C., and Robert J. Brod. BASEMENT MAPPING WITH AEROMAGNETIC DATA - BLIND RIVER BASIN: Geophysics, v. 25, no. 3, p. 586-601, 11 figs. incl. 8 maps, secs., June 1960, 7 refs.

A detailed aeromagnetic map at 1,700 ft. of 16 sq. mi. of the U-producing Blind River basin of Ontario, Canada, shows anomalies interpreted to originate from shallow basic intrusives and deeper basement rocks. The identification of a major basement fault from a basement anomaly is described after demonstrating the isolation of these anomalies from the intrusive rocks on the basis of calculations of their depths. An aeromagnetic map computed upward to 2,630 ft. and 2 second vertical derivative maps confirm the identification of the 2 categories of anomalies. Later drilling tends to confirm the existence of the fault.

The entire study is considered applicable to much larger aeromagnetic surveys because all types of anomalies are present within this small area where they can easily be correlated with their origins.--Auth.

2-2047. Gusev, B.V. AGE OF ALKALINE-ULTRABASIC ROCKS OF MAYMECHA-KOTUY REGION ACCORDING TO PALEOMAGNETIC DATA. Translated by A.J. Shneiderov: Internat. Geology Rev., v. 2, no. 4, p. 327-329, 2 tables, Apr. 1960, 4 refs.

Investigations of widely distributed negative magnetic anomalies in the Maymecha-Kotuy region (72° N., 102° E.), showed that remanent magnetization is present in the rocks and that they could be subdivided into magnetically stable and unstable categories. Studies were based on 1,600 oriented rock samples. Paleomagnetic data derived from mean directions of magnetization were used to calculate the N. Polar coordinates for the time of formation for the various rocks. These data can be compared to mean values of N. Polar coordinates determined for various periods. Mean values for the N. Polar coordinates derived from remanent magnetization data on basic and ultrabasic rocks of the Maymecha-Kotuy region correspond to those of Permian-Carboniferous time. No paleomagnetic age correlation was possible for magnetically unstable rocks. Results disagree with paleontological data, which indicates these rocks to have formed in late Permian to early Triassic times; however, they are found to agree with data derived by the Ar method. A correction of 20° mean value of dip in meymechites was incorporated into the calculations, with the result that the corresponding polar coordinates were 44° N., 148° E., and in agreement with findings for all other rocks. Thus, meymechites probably were formed as a horizontal layer and later uplifted by younger intrusion of dunite-peridotite magma. They are probably of effusive origin. It is believed that this method can be used eventually for more extensive determination of age correlation for various rocks and massifs.--D.D. Fisher.

2-2048. Vinogradov, P.A. THE VERTICAL COMPONENT OF THE EARTH'S ELECTRIC FIELD IN LAKE BAIKAL: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 1, p. 47-48, 3 figs., pub. Apr. 1960, 8 refs.

The results of the observations and measurement of the vertical component of earth currents in lake Baikal are presented. The observations were made at 2 pairs of points, 500 m. apart, along an E.-W. and a N.-S. line. The electrodes were Pb plates 0.4 m^2 in area. The electrodes on the E.-W. line were suspended at depths of 5,200 m. and 1,000 m., and those along the N.-S. line at depths of 5 m. and 400 m. Special attention was given to the measurement of variations of the vertical component of the geoelectric field. Vinogradov found that the short-period variations occur simultaneously in the water of lake Baikal and at the Zuye geophysical station, some 80 km. from the lake. Several oscillograms showing the vertical currents are reproduced.--S.T. Vesselowsky (courtesy Geophysical Abstracts 177-29).

2-2049. Skugarevskaya, O.A. CALCULATION OF THE FINAL STAGE IN THE ESTABLISHMENT OF AN ELECTRIC FIELD IN THREE LAYERS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation,

on, 1959, no. 1, p. 35-41, 3 figs., pub. Apr. 1960, refs.

Following the method used by Tikhonov in his computation of a similar problem for a 2-layer medium, Skugarevskaya solves the problem for a medium consisting of 2 horizontal homogeneous and isotropic layers, overlying a perfectly insulating formation of infinite thickness.

The problem has been reduced by Tikhonov to the analysis of Maxwell equations for a quasi-stationary case. Skugarevskaya uses a vectorial treatment in the analysis. This method can also be used for solving boundary value problems and for the evaluation of the final phase of the transient of the electromagnetic field in a medium composed of any number of layers.--S. T. Vesselowsky (courtesy Geophysical Abstracts 178-125).

-2050. Chetaev, D.N. AN INVERSE THEORETICAL PROBLEM IN THE ELECTRICAL PROSPECTING OF NONCONDUCTIVE BEDS EMERGING AT THE SURFACE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 1, p. 42-46, pub. Apr. 1960, 12 refs.

The method developed in his previous study for the solution of the inverse boundary value problem in two-dimensional electrical exploration is applied to the case of nonconducting strata that crop out and strike parallel to the surface contours. The suggested method of analytical interpretation of the results of the surveying makes it possible to check the validity of its use. The computed topography deviates considerably from the real, owing to inconsistent assumptions made in the solution of the problem; therefore, the results must be considered doubtful.

The results of this study can be extended to solving analogous problems in the case of ore bodies that are good conductors.--S. T. Vesselowsky (courtesy Geophysical Abstracts 177-106).

-2051. Tikhonov, A.N., and A.G. Sveshnikov. ON THE SLOW MOTION OF CONDUCTING MEDIUM IN A STATIONARY MAGNETIC FIELD: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 1, p. 30-34, graph, pub. Apr. 1960, 6 refs.

Effects are discussed that occur during the movement of a conducting medium in a stationary magnetic field, such as ocean currents moving in the geomagnetic field. Applying a rather extensive analysis of the basic equations of electromagnetic fields, Tikhonov and Sveshnikov derive the relations between the velocity of the current and the intensity of the electric field induced by the magnetic field of the earth. In these relations the width of the current as well as the conductivity of the ocean bottom over which the currents move are taken into account. The unknown velocity of the current at different points can be computed and the vertical cross section of the velocity distribution in the moving medium can be obtained by these formulas.--S. T. Vesselowsky (courtesy Geophysical Abstracts 177-32).

-2052. Wait, James R. ON THE ELECTROMAGNETIC RESPONSE OF A CONDUCTING SPHERE TO A DIPOLE FIELD: Geophysics, v. 25, no. 3, p. 49-658, fig., June 1960, 8 refs.

The electromagnetic coupling between an electric and a magnetic dipole in the presence of a spherical body is discussed. Both electric and magnetic

modes must be considered even though all dimensions are small compared to the wave length. The results have application to a geophysical prospecting scheme where the exciting fields are set up by a straight insulating wire grounded at its end points and the secondary fields are detected by an ungrounded closed wire loop.--Auth.

2-2053. Angona, F.A. TWO-DIMENSIONAL MODELING AND ITS APPLICATION TO SEISMIC PROBLEMS: Geophysics, v. 25, no. 2, p. 468-482, 13 figs., Apr. 1960, 22 refs.

Laboratory seismograms of a fault model demonstrate the mechanism for diffraction and clearly show the difference in amplitude decay and moveout between a reflection and a diffraction. The inverted order and the deflection to the side of reflected energy from a curved reflector with a buried focus is demonstrated. A comparison is made of seismograms from a simple fault model and from one combining a fault with curved reflectors leading to it. The curved surfaces increase the overlap of the reflected events and mask the fault. Modeling techniques, involving the control of the reflection coefficient between layers by thickness variations and the control of the propagation velocity through a layer by combining 2 or more materials into a laminated sheet, are demonstrated.--Auth.

2-2054. Melamud, A.Ya., L.L. Khudzinsky, and S.A. Deinega. A STATION FOR INTERMEDIATE MAGNETIC RECORDING OF SEISMIC WAVES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 2, p. 128-137, 9 figs., incl. 4 diag., graph, pub. May 1960, 35 refs.

A description of Russian apparatus designed for intermediate recording of seismic vibrations, using the method of frequency modulation. The instruments are designed for frequencies ranging from 20 to 500 cycles per sec. and can be combined with equipment designed for low, middle, and high frequencies. The range of the useful frequency can be increased by a simple modification of the preamplifier wiring. Thus, the frequency spectrum of the station could be adapted for use as an intermediate recording station in deep seismic exploration. A great advantage of the station described is the precise reproduction of the records for detailed analysis in the laboratory. The installation does not produce any additional distortion of recorded vibrations and thus can be used in studies of the dynamic characteristics of seismic waves. The apparatus can easily be built as a portable station.--S. T. Vesselowsky (courtesy Geophysical Abstracts 177-356).

2-2055. Rykov, A.V. A PHOTO-ELECTRIC DEVICE FOR RECORDING THE ENERGY FLUX OF SEISMIC WAVES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 1, p. 98-101, 8 figs., pub. Apr. 1960, 6 refs.

Rykov describes an apparatus which automatically measures the square of the velocity of displacement of the ground and integrates the obtained quantity with respect to time. The main element of the apparatus is a photoelectric amplifier provided with an opening so shaped that the original beam of light, after passing through the opening, illuminates an area proportional to the square of the original deflection of the galvanometer. Finally an integration of the amplified deflection is produced. The apparatus

was tested in the laboratory and showed good results. --S. T. Vesselowsky (courtesy Geophysical Abstracts 177-73).

2-2056. Shakurov, P. F. HIGH-FREQUENCY APPARATUS FOR THE DETERMINATION OF THE SURFACE INCLINATION OF THE EARTH AND FOR RECORDING OF EARTHQUAKE WAVES: Akad. Nauk SSSR, *Izvestiya, Geophysics Ser.*, in translation, 1959, no. 1, p. 102-103, 2 illus., diag., pub. Apr. 1960.

An instrument for measuring small inclinations of the ground with high precision, not yet tested in practice, is described. The principle of the instrument consists in the use of 2 concentric spherical shells, having the same radii of curvature and polished to optical precision so that the upper shell can roll in the other. To decrease friction during the rolling, a stream of slightly compressed air is blown in through a small opening 0.2-0.3 mm. in diameter at the middle point of the lower sphere. This stream keeps the upper shell "floating" in the lower one. The distance between the 2 shells will be about 10μ . Shakurov estimates that the amount of air necessary for this, compressed to 0.4 atm., will be about 30 l. for 24 hours. The equilibrium position of the upper shell corresponds to the minimum of its potential energy. The precision is such that an angle of the inclination of 1 sec. or even 0.02 sec. can be positively determined if a sufficient optical magnification is used. --S. T. Vesselowsky (courtesy Geophysical Abstracts 177-74).

2-2057. Skuridin, G. A. DUHAMEL'S PRINCIPLE AND ASYMPTOTIC SOLUTIONS OF THE DYNAMIC EQUATIONS OF ELASTICITY THEORY, I: Akad. Nauk SSSR, *Izvestiya, Geophysics Ser.*, in translation, 1959, no. 1, p. 1-4, pub. Apr. 1960, 13 refs.

Continuing his previous studies on the physical validity of the discontinuous solutions of the dynamic equations of the theory of elasticity, Skuridin discusses the case where the asymptotic solutions show discontinuities, but none of them becomes infinite. Skuridin proves that the stated asymptotic solutions satisfy the initial system of differential equations. The treatment is vectorial. Duhamel's principle is used for evaluation of the solutions obtained. The application of Duhamel's integral is based on the previous determination of the response of the vibrating system to a unit impulse and the determination of the indicial admittance of the system, because it is based on the principal of superposition, applicable to all cases where only linear differential equations fully describe the problem. Finally, the solution is obtained; in the case of a harmonic source of vibrations this can be presented as an inverse power series. The established series are applicable to numerous boundary value problems but not to those of diffraction, because there the possibility exists of the appearance of infinite discontinuities. --S. T. Vesselowsky (courtesy Geophysical Abstracts 178-90).

2-2058. Miles, John W. SCATTERING OF ELASTIC WAVES BY SMALL INHOMOGENEITIES: *Geophysics*, v. 25, no. 3, p. 642-648, fig., June 1960, 7 refs.

Rayleigh scattering theory is extended to determine the perturbation on an arbitrarily prescribed elastic wave field produced by small inhomogeneities

in an otherwise homogeneous, isotropic medium. The general result is applied to the specific problems of the scattering of both plane P- and S- waves. It is found that a change in compressibility acts at a distance as a simple source and a change in density as a dipole, as in the acoustical problem, while a change in shear modulus contributes both simple-source and quadrupole fields. --Auth.

2-2059. White, J. E. USE OF RECIPROCITY THEOREM FOR COMPUTATION OF LOW-FREQUENCY RADIATION PATTERNS: *Geophysics*, v. 25, no. 3, p. 613-624, 5 figs., June 1960, 8 refs.

Starting with a simple word statement of the reciprocity which exists between forces and displacements in a general elastic solid, it is shown that low-frequency radiation of shear and compressional waves from relatively complex sources can be obtained by solving relatively simple problems in static elasticity. Illustrative examples include radiation from radial and tangential pairs of forces acting on the wall of a cylinder, pressure in a finite cylinder, and a pair of radial forces in a hole in a plate. For the last case, measurements in a plexiglas plate compare favorably with computations. --Auth.

2-2060. Vinogradov, S. D. ELASTIC IMPULSES ORIGINATING IN A MASSIF UNDER PRESSURE: Akad. Nauk SSSR, *Izvestiya, Geophysics Ser.*, in translation, 1959, no. 2, p. 195-198, 6 figs., pub. May 1960, 7 refs.

Investigation of the intensity of elastic pulses appearing as the result of the application of pressure in a salt massif by artificial means has shown that with a suddenly-applied constant pressure the intensity varies with time in accordance with a law having the form $W = c t^k$. In the experimental investigations performed the value k proved to be close to unity.

Correlation with work done on rock creep showed that intensity under the conditions of the experimental investigations performed varies with time in accordance with the same law as does the deformation rate.

A study made of the acoustical phenomena in a coal massif and a comparison of such phenomena with seismic observations showed a qualitative connection between the intensity of the acoustical phenomena and the deformation rate.

In a study of the stress distribution in the massif and of the phenomena connected with rock pressure the observation of the elastic pulses must be carried out in conjunction with the observation of the seismic characteristics of the rocks. A correct understanding regarding the processes taking place in the massif can be reached only through a correlation of the data of the acoustical and of the seismic observations. --Auth. concl.

2-2061. Spencer, T. W. THE METHOD OF GENERALIZED REFLECTION AND TRANSMISSION COEFFICIENTS: *Geophysics*, v. 25, no. 3, p. 625-641, 2 figs., June 1960, 7 refs.

The objective of this work is to provide a method for predicting the surface response of a stratified half space to the radiation from a localized source when neither the assumptions of the plane wave theory nor the assumptions of the normal mode theory are valid. The earth model consists of a finite number of perfectly elastic, homogeneous, isotropic layers separated by interfaces which are plane and parallel

another.
The method leads to an infinite series for the transform of the response function (displacement, velocity, stress, etc.) in a multi-interface medium. Each term in the series describes all the rays which traverse a particular generalized ray between the source and the receiver. The specification of the mode of propagation across each stratum (either as an irrotational wave or as an equivoluminal wave) and of the sequence in which the strata traversed serve to define a generalized ray path. A description is given for constructing the integral representation for the disturbance which has traveled such a path directly from the integral representation for the source radiation. The method therefore obviates the necessity for solving a tedious ray value problem. The time function associated with each term can be obtained by using Cagniard's method.--Auth.

32. Tsepelev, N.V. REFLECTION OF ELASTIC WAVES IN A NON-HOMOGENEOUS MEDIUM: *Izv. Akad. Nauk SSSR, Izvestiya, Geophysics Ser.*, in translation, 1959, no. 1, p. 5-8, fig., pub. Apr. 1960, 5 refs.

This article is a continuation of a previous study by Tsepelev and Tsepelev. The problem of the determination of the effect of certain surfaces on the propagation of elastic waves in heterogeneous media is discussed. There are surfaces on which the gradient of velocity and density are discontinuous. It is shown that such boundaries act as reflecting planes. The corresponding coefficients of reflection and refraction are computed, and the shapes of the reflected and refracted waves are determined; these shapes differ in shape from the incident wave. The analysis can be extended to the case when the k -th derivatives of velocity and density undergo discontinuities of the boundary.--S.T. Vesselowsky (courtesy Geophysical Abstracts 177-81).

33. Chekin, B.S. REFLECTION AND REFRACTION OF SEISMIC WAVES AT A WEAK INTERFACE: *Izv. Akad. Nauk SSSR, Izvestiya, Geophysics Ser.*, in translation, 1959, no. 1, p. 9-13, fig., pub. Apr. 1960, 5 refs.

Assuming as an approximation the beam method for solving the problem of wave propagation in a heterogeneous medium, Chekin discusses the reflection and refraction of seismic waves on a weak boundary between 2 media. Characteristic of the problem is the fact that discontinuities of the velocity gradient and of Lamé coefficients take place on this boundary. In the treatment of the problem the vector method is used. As a result of his mathematical analysis, Chekin obtains expressions physically equivalent to the coefficients of reflection and refraction on this boundary.--S.T. Vesselowsky (courtesy Geophysical Abstracts 177-83).

34. Berzon, I.S., Yu.P. Vassilev, and S.P. Dubrovskaya. WAVE REFRACTION BY AQUICLUS SANDS. I: *Izv. Akad. Nauk SSSR, Izvestiya, Geophysics Ser.*, in translation, 1959, no. 1, p. 17-20, pub. Apr. 1960; II: 1959, no. 2, p. 115-118, pub. Apr. 1960, 18 figs. incl. map, 9 graphs, 41 refs.

2 pts. Experimental study of the kinematic and dynamic characteristics of waves refracted on the interface of water-bearing sand shows that the longitudinal (head) waves are characterized by a higher

frequency spectrum than the same waves refracted on argillaceous strata ordinarily having comparable seismic velocities. This makes it necessary to use high frequency instruments. Boundary velocities in sand range from 1,500 to 1,800 m. per sec. The damping coefficients of seismic waves in sands vary from 0.002 to 0.004 m^{-1} . Dipping refracting planes usually are related to higher values of damping. The experiments show the importance of the observation of dynamic characteristics of the wave in broadening the possibilities of interpretation of seismic data. It is possible to distinguish water-bearing formations from others with similar velocity and a slightly different frequency. Studies of amplitudes and of damping coefficients represent an approach to the study of the physical properties of sands.

In the second part of the study, the causes of marked changes of the absorption coefficient in a sand layer are discussed. These changes, which occur simultaneously with relatively unimportant changes in boundary velocities (from 1,500 to 1,800 m. sec. $^{-1}$), are found to be related to a reduction of the relief of the surface in question. They have been explained to be a result of incomplete saturation of the sand in some places, a portion of the pores remaining filled with air. The sand at these places must then be regarded as a 3-component medium. A theoretical analysis of the behavior of the velocity of such waves in a 3-component medium shows that this factor does not explain the observed velocity variations. The cause probably lies in variation of porosity and physical composition of the sands; this hypothesis will be investigated in subsequent studies.--S.T. Vesselowsky (courtesy Geophysical Abstracts 177-349).

2-2065. Gogoladze, V.G. REFLECTION AND REFRACTION OF ELASTIC WAVES, GENERAL THEORY OF BOUNDARY RAYLEIGH WAVES. Translated by I.I. Peters and H.P. Thielman: *Internat. Geology Rev.*, v. 2, no. 5, p. 418-452, 13 figs., May 1960, 22 refs.

The problem of reflection and refraction of elastic waves in different media getting in touch along a plane is solved in this work. The problem has received complete solution owing to an investigation of the complex nonstationary waves and boundary Rayleigh waves which arise with reflection and refraction of elastic waves. The investigation is based upon an examination of the roots of some function of a complex variable over the total plane of the latter. In result of a complete investigation of the properties of this function are determined laws of reflection, refraction, and appearance of Rayleigh waves. In the work such conditions are given which are necessary and sufficient for the appearance of Rayleigh waves at different disturbances.--Auth.

2-2066. Keylis-Borok, V.I., and I.M. Stesin. THE DISPERSION OF RAYLEIGH WAVES IN A TWO-LAYER MODEL OF THE EARTH'S CRUST: *Izv. Akad. Nauk SSSR, Izvestiya, Geophysics Ser.*, in translation, 1959, no. 1, p. 14-16, 4 figs., pub. Apr. 1960, 8 refs.

A theoretical analysis is made of Rayleigh wave dispersion in a crust composed of 2 layers of different thickness, granitic and basaltic. Each layer is assumed to be homogeneous, isotropic, and perfectly elastic; the contacts on the boundary planes are assumed to be rigid and the upper boundary to be stress free. The results of the computations are

compared with recently published experimental data obtained by Press and Ewing; the correspondence is found to be good. --S. T. Vesselowsky (courtesy Geophysical Abstracts 177-90).

2-2067. Collins, Francis. PLANE COMPRESSIONAL VOIGT WAVES: *Geophysics*, v. 25, no. 2, p. 483-504, graph, Apr. 1960, 17 refs.

The Voigt wave equation, long considered a possible mathematical model for seismic waves, was extensively studied in 1943 by Norman Ricker, who developed an asymptotic solution applicable at sufficiently large distances from the shotpoint. Ricker's solution does not agree with his field results in all respects. For example, Van Melle has shown that Ricker's wavelets decay too rapidly with distance to be consistent with the experimental data. This particular difference between theory and observation may arise from the form of the wave source implicitly assumed by Ricker, a doublet impulse of displacement.

A single impulse of pressure seems a more reasonable first approximation to the shot. For this source a complete solution for plane waves is developed, valid for all distances and times. A method similar to Ricker's is then outlined for obtaining an asymptotic solution suitable for computations at large distances.

The wavelets from the pressure impulse do not decay as rapidly as Ricker's doublet displacement solutions. This is a move toward better agreement with experiment. On the other hand, the pressure impulse wavelets have only a single lobe, a definite move away from the observations. There is some reason to believe, however, that the corresponding spherical waves would be more oscillatory than the plane waves.

More mathematical work is needed for further tests of the Voigt solid as a theoretical model for earth waves. The next step suggested is the computation of spherical waves from a pressure impulse. --Auth.

2-2068. Konstantinova, A.G. DYNAMICS OF INSTANTANEOUS COAL AND GAS OUTBURSTS IN MINES, INFERRED FROM SEISMO-ACOUSTICAL OBSERVATIONS: *Akad. Nauk SSSR, Izvestiya, Geophysics Ser.*, in translation, 1959, no. 2, p. 150-158, 7 figs., pub. May 1960, 29 refs.

A study based mainly on material collected during seismoacoustic observations during the rockburst of Apr. 7, 1954, in the Yunkom coal mine, central Donets basin. The material analyzed included oscillograms, spectrograms, and phonograms recorded in the mine during the rockburst. The total duration of the rockburst was about 23 sec. The oscillograms indicate that the rockburst can be divided into 3 cycles. Each cycle lasted about 8 sec. and can be divided into 2 parts. The first part lasted about 5 sec. and is characterized by low frequencies (largely 150 to 300 cycles per sec.). The second part is characterized by higher frequencies and also a greater range of frequencies (600 to 1,600 cycles per sec.). The overlap of the low and high frequency intervals is only a few tenths of seconds.

An analysis of the data makes it possible to establish certain characteristics of the rockburst process. The greatest destruction was produced by the splitting off of a mass of coal and of the walls of the mine gallery; these were pulverized. This splitting was

caused by the pressure of the overburden to which the mine gallery is exposed from all sides except from the face of the workings. The pressure of the gas contained in the coal can be a contributing factor. The article reproduces many oscillograms, showing the process at different stages. --S. T. Vesselowsky (courtesy Geophysical Abstracts 177-348).

2-2069. Shumway, George. SOUND SPEED AND ABSORPTION STUDIES OF MARINE SEDIMENTS BY A RESONANCE METHOD: *Geophysics*, v. 25, no. 3, p. 451-467, Apr. 1960; no. 3, p. 659-682, May 1960, 12 graphs, tables, 53 refs.

In 2 pts. Laboratory measurements of compressional sound speed and absorption have been made on 111 unconsolidated marine sediment samples, ranging from shallow-water sands to deep-sea clays. In addition, determinations were made of porosity, wet density, and grain size distributions. Frequencies between 20 kc./sec. and 27 kc./sec. were used for the acoustic studies.

Sound speed values at room temperature range from 1.474 km./sec. for a red medium clay to 1.78 km./sec. for a medium sand. More than one-third of the values are lower than the value for sea water alone. Variations in the speed of sound in unconsolidated sediments as found in nature are caused by the following factors in order of importance: 1) porosity, because of the great difference in compressibility of water and mineral grains; 2) the factor which produces rigidity, which appears to be related to the abundance of coarse grains; 3) pressure; 4) temperature; 5) compressibility of the grain aggregate, determined from compressibilities of individual minerals.

Sound absorption measurements ranged from 0.5 db/m. for a medium clay (28.4 kc./sec.) to about 20 db/m. for silts and fine sands (between 30 and 37 kc./sec.). An absorption maximum occurs for sediments of intermediate porosity (0.45-0.6) and intermediate grain size (0.031 mm.-0.25mm.). The expression $\alpha = M A_g$, where α is the linear absorption coefficient, M is a frequency-dependent factor related to the sediment volume fraction of grains in mutual contact, and A_g is a computable total acoustically effective grain surface area, predicts the absorption values and the absorption maximum.

Absorption measurements at more than one frequency between 20 kc./sec. and 37 kc./sec. were obtained for 65 samples. Assuming that absorption is directly proportional to frequency raised to a power n , the data yield an average value of n equal to 1.79, with a standard deviation of 0.98. --Auth.

2-2070. Volarovich, M.P., and E.I. Parkhomenko. MODELLING THE CONNECTION BETWEEN SEISMIC PHENOMENA AND DISTURBANCES IN THE ELECTRICAL FIELD OF ROCKS DUE TO THE PIEZOELECTRIC EFFECT: *Akad. Nauk SSSR, Izvestiya, Geophysics Ser.*, in translation, 1959, no. 1, p. 90-92, 2 figs., pub. Apr. 1960, 3 refs.

Laboratory experiments were made on the piezoelectric effect in rocks accompanying seismic phenomena. For this purpose blocks of granite, marble, a labradorite were tested; these blocks had different dimensions but were on the order of 30X15X5 cm. Granite generally shows a piezoelectric effect due to the presence of quartz grains, whereas marble and labradorite, which are generally free from quartz, show negligible effects. Seismic shocks were imitated by pulses produced by a piezoelectric seismo-

Elastic waves propagating through the tested from the point of impact, as well as elastic propagating from the points where the quartz were present in the block, have been observed recorded by an oscilloscope. The oscillograms that one ray is formed by elastic waves propagating from the point of impact. Another ray consists of electric waves propagating from quartz grains of the specimen; this is the piezoelectric effect. Electric waves are propagated with the velocity of light, whereas the elastic waves have a much lower velocity. Both types of waves can be readily observed. Volarovich and Parkhomenko point to the fact that these experiments explain transient anomalies of the electric field often observed during seismic phenomena in many regions.--S.T. Vesselowsky (Geophysical Abstracts 178-158).

1. Magnitsky, V.A., and V.A. Kalinin. THE PROPERTIES OF THE EARTH'S MANTLE AND THE PHYSICAL NATURE OF THE TRANSITION LAYER: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 1, p. 49-54, 6 figs., table, Apr. 1960, 33 refs.

An attempt is made in this paper to evaluate different hypotheses concerning the physical causes of the change of seismic velocity in Bullen's transition zone in the mantle. One of the first explanations of the change in chemical composition, corresponding to the generally assumed theory that the proportion of heavy atoms, mainly of Fe, increases with depth. As this assumption led to contradictions with geophysical data, a correction was introduced into the percentage of Fe increase only to the depth of 100 km., but this in turn led to contradictions of the resulting properties of the underlying D layer with the seismological evidence.

Others have advanced the idea of a polymorphic transition without changes in chemical composition. The existing block, however, is the suddenness of the changes, whereas the change in seismic velocity takes place gradually over several hundreds of kilometers. Magnitsky explains the changes in velocity by a transition of the substance from ionic type of bonds to covalent bonds. This change can take place gradually. Certain other physical properties could be mentioned as confirming this hypothesis. Insufficient knowledge of the state of solids under high pressure and temperature makes all conclusions on this subject still conjectural.--S.T. Vesselowsky (courtesy Geophysical Abstracts 177-238).

2. Ivakin, B.N. ELASTIC MEDIA WITH IMPERFECT INERTIA AND THEIR MODELS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 2, p. 138-144, 2 figs., pub. May 1960, 7 refs.

Imperfect media (and their models) are investigated which possess imperfect inertia of masses of the medium. By this the analogy of equations of motion is shown for earlier investigated media with imperfect elasticity (and their models) to the equations of motion for those investigated here of perfect elastic media with imperfect inertia (and their models), consequently, the analogy is shown of the dispersion of velocity and absorption of waves in these basically different media.

The difference of a medium with elastic afterworking or in general with imperfect elasticity from a medium with inertial afterworking or in general

with imperfect inertia comes down to the difference of their acoustic impedances. If with increasing frequency the modulus of the acoustic impedance of the medium with imperfect elasticity always increases, then, for a medium with imperfect inertia it always decreases. If in the medium with imperfect elasticity where the argument of the acoustic impedance is always positive, the wave of pressure (the electrical voltage in the electrical model) always leads the wave (of velocity) of displacement (the wave of electrical current), then, in a medium with imperfect inertia where the argument is always negative, on the contrary, the wave of pressure (voltage) always lags behind the wave (of velocity) of displacement (current). This difference in the behavior of the acoustic impedances and phase shift of the waves to frequency can be employed as a criterion for distinction between the imperfect elasticity and imperfect inertial mechanisms of absorption (or the predominance of one of these mechanisms) during an experimental verification of the theory of absorption in real media.

In connection with the fact that a real medium possesses rather simultaneously both imperfect elasticity and imperfect inertia, the absorptive medium (and its models) with elastic and inertial afterworking is discussed, taking the function of afterworking to be of the Sokolov-Skryabin type. In the particular case of such a medium when the similar constants of elastic and inertial afterworking are equal, the acoustic impedance is not related to the frequency (it becomes compensated at all frequencies). However, the dispersion of velocities in this case remains such that with increasing frequency the medium with elastic and inertial afterworking not only gains greatly effective elasticity ("hardens") but also become effectively less dense (more "light").

It is possible, consequently, that spectra of constants of afterworking exist (the inverse values of the relaxation times of deformation and stress) for imperfect elastic and imperfect inertial real media. One can expect that in a given medium for small anomalous dispersion of velocity, the decrement of absorption will be small or in general will not be related to the frequency for the broad band of frequencies that are usually found for rocks.--From author's concl.

2-2073. Mann, Robert L., and Irving Fatt. EFFECT OF PORE FLUIDS ON THE ELASTIC PROPERTIES OF SANDSTONE: Geophysics, v. 25, no. 2, p. 433-444, 3 illus., 6 graphs, 3 tables, Apr. 1960, 4 refs.

Bulk compressibility, Young's modulus, and Poisson's ratio were measured on 3 sandstones. Measurements were made on both dry and water saturated samples. Several runs were made on each sandstone to establish the statistical validity of the differences observed between the wet and dry samples. Bulk compressibility of wet sandstone was 10 to 30% greater than for dry. Young's modulus was 8 to 20% less for wet sandstone, and Poisson's ratio was 100% greater on one type of sandstone when wet and only slightly greater or about the same on wet samples of the others. A high clay content is believed to lead to a large effect of water on the elastic moduli of sandstone.--Auth.

2-2074. Silaeva, O.I. METHODS FOR THE STUDY OF THE ELASTIC PROPERTIES OF ROCK SAMPLES UNDER PRESSURE: Akad. Nauk SSSR, Izvestiya,

Geophysics Ser., in translation, 1959, no. 2, p. 145-149, 4 figs., 2 tables, pub. May 1960, 23 refs.

This paper deals with the elastic properties of rocks and the degree of absorption of energy in specimens subjected to pressure up to 1,000 kg. per cm^2 . The ultrasonic impulse method was used. The pressure on the specimens was applied only along one axis. Maximum pressure applied corresponds to a depth of about 4 km. underground. The experiments show that with increasing pressure the elastic parameters (Young's modulus, rigidity modulus, and Poisson's coefficient) increase, whereas the absorption of elastic waves decreases. The results prove that the elastic properties of rocks and the absorption coefficients of elastic waves propagating in them can be reliably studied in the laboratory.--S. T. Vesselowsky (courtesy Geophysical Abstracts 177-97).

2-2075. Petkevich, G.I. CONTRIBUTION TO THE STUDY OF ELASTIC PROPERTIES OF CISCARPATIAN ROCKS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 2, p. 210-213, 3 figs., table, pub. May 1960, 6 refs.

A comparison of the seismic velocity values determined in the laboratory on specimens of rocks under atmospheric pressure, with the values established from well-shooting data on the same rocks, permits individual factors that govern wave velocity under specific geologic conditions to be distinguished; further, the effect of these factors can be calculated, thus eliminating great difficulties connected with the determination of seismic velocity of rocks in place.

Laboratory determinations were made using an ultrasonic impulse seismoscope suggested by Riznichenko with a frequency of 140 cycles per sec., following the procedure of "resounding." The dimensions of the tested specimens were those recommended by Silaeva and Shamina. Specimens were taken from 4 drill holes from a depth range of 100 to 3,000 m. The most important conclusion is that it is possible to establish a definite empirical correlation between the results of laboratory measurements and data. The difference between the 2 sets of values decreases with depth. Results are presented in a table and graphs.--S. T. Vesselowsky (courtesy Geophysical Abstracts 177-98).

2-2076. Richards, T.C. WIDE ANGLE REFLECTIONS AND THEIR APPLICATION TO FINDING LIMESTONE STRUCTURES IN THE FOOTHILLS OF WESTERN CANADA: Geophysics, v. 25, no. 2, p. 385-407, 13 figs. incl. map, sec., graphs, seismograms, Apr. 1960, 10 refs.

Experimental and theoretical evidence is presented to show that a strong seismic event, occurring late in a record and at distances beyond the critical distance, is a wide angle reflection and not a refraction from a high velocity limestone formation.

The evidence includes studies of the effects of anisotropy on the velocities along reflected and refracted paths and of the variation of amplitude of the event with distance. The paper also describes how the results of broadside wide angle reflection shooting may be combined with normal reflection shooting to map strongly dipping limestone structures. An application to a profile through a foothills well in western Canada is included.--Auth.

2-2077. Byerly, P. Edward, Samuel W. Stewart, and J.C. Roller. SEISMIC MEASUREMENTS BY

THE U.S. GEOLOGICAL SURVEY DURING THE PT Gnome HIGH-EXPLOSIVES TESTS NEAR CARLSBAD, NEW MEXICO: FINAL REPORT: U.S. Geol. Survey, Trace Elements Inv. Rept. 761, 40 p., 9 figs., 4 seismic recordings (in pocket), table, Apr. 1960, 15 refs.

The U.S. Geological Survey monitored 3 high-explosive test shots at the Gnome site during the pre-Gnome experiments and monitored routine blasting in the potash mine of the Duval Sulphur and Potash Company.

Analysis of the data leads to the conclusion that the motion in the potash mines near Carlsbad from a shot of 9 kt. of TNT at the Gnome site, 46,000 ft. from the nearest potash mine, would not exceed:

displacement:	0.1	-	0.2 cm.
velocity:	1.5	-	3 cm./sec. @ 2 c.p.s.
	2.5	-	5 cm./sec. @ 4 c.p.s.
acceleration:	0.02	-	0.04g. @ 2 c.p.s.
	0.06	-	0.12g. @ 4 c.p.s.

These particle velocities and accelerations are less than those recorded at a distance of 90 ft. from a routine 75-lb. dynamite blast in a potash mine.--Auth.

2-2078. Warrick, R.E., and John D. Winslow. APPLICATION OF SEISMIC METHODS TO A GROUND WATER PROBLEM IN NORTHEASTERN OHIO: Geophysics, v. 25, no. 2, p. 505-519, 8 figs. incl. 2 maps, sec., profiles, Apr. 1960, 5 refs.

Valleys cut in the bedrock in northeastern Ohio by Tertiary and Pleistocene streams have been filled by Pleistocene glacial drift so that there is little surface evidence of their existence. Some of these buried valleys are good sources of ground water, so information regarding the location, depth, and cross section of the buried valleys is important in water-supply investigations. Detailed knowledge of the configuration of the buried valleys is useful also in interpreting the glacial history of the region. Test surveys in Portage and Summit counties, Ohio, by the U.S. Geological Survey indicate that seismic methods can be used to determine depth to bedrock and thus to be applicable to the study of the buried valleys.--Auth.

2-2079. Iokhelson, S.V., and E.V. Shitov. RADIOMETRIC ANALYSIS OF ROCKS ACCORDING TO THE SPECTRUM OF GAMMA-RADIATION: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 1, p. 55-62, illus., 2 diagrs., 4 graphs, 2 tables, pub. Apr. 1960, 6 refs.

The isotopic composition of a mixture of elements emitting gamma rays can be determined by the distribution of the pulse amplitudes on the exit end of a differential gamma-ray spectrometer provided with an oscillograph. Examples of the use of the suggested arrangement, called radiometric analysis, are given illustrating the determination of U, Ra, and Th content in rocks and ores. The wiring diagram and the basic scheme of the entire installation are given. The results of the radiometric analysis of specimens of rocks are in good agreement with the chemical analyses. The possibilities of application of radiometric analysis are wide, as the method is free of errors that are due to the absorption of external radiation by the specimens.--S. T. Vesselowsky (courtesy Geophysical Abstracts 177-317).

2-2080. Moxham, Robert M. AIRBORNE RADIO-ACTIVITY SURVEYS IN GEOLOGIC EXPLORATION: Geophysics, v. 25, no. 2, p. 408-432, 11 figs. incl. maps, profiles, Apr. 1960, 23 refs.

The value of airborne radioactivity surveys in guiding U exploration has been well established. Improved circuitry and development of semiquantitative analytical techniques now permit examination of more complex geologic problems. It is shown that the airborne technique can be used in exploration for Th-bearing heavy mineral deposits and for uraniferous phosphorites.

The observed radiation intensity and configuration of the gamma radiation field may be used to approximate the equivalent U content and extent of the surficial part of such deposits. The equivalent U content of infinite sources can probably be determined within a few thousandths of a percent and the boundaries fixed within a few hundred feet. As the areal extent of the source decreases, the accuracy of the analytical results likewise decreases.--Auth.

2-2081. Safronov, V.S. ON THE PRIMEVAL TEMPERATURE OF THE EARTH: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 1, p. 85-89, 2 graphs, pub. Apr. 1960, 17 refs.

The question of the primordial temperature of the earth is closely related to the problem of the earth's origin and development. High temperatures have influenced its development and in turn been affected by different phases of the earth's growth. The high potential energy of the earth suggests that at the time of its formation a vast amount of energy was evolved. Most of this energy was dissipated as heat into space, but only a small fraction of the initial amount of energy may have been sufficient to bring the temperature of the earth to several thousand degrees K. The analysis of the process of growth of the earth as a result of precipitation on terrestrial nuclei of matter falling from the protoplanetary cloud leads to the conclusion that the formation of earth was

completed in about a hundred million years, during which time the temperature of the earth's center reached about 1,000°K. The sources of this heating were disintegration of radioactive elements and compression of the matter during the growth of the earth. Heating due to the impact of falling bodies was relatively unimportant. The subsequent heating of the earth was due to radioactivity. Over a period of 5 billion years the radioactive elements could have raised the temperature of the earth's interior a few thousand degrees. This heating strongly influenced the evolution of the earth, particularly the formation of its crust.--S.T. Vesselowsky (courtesy Geophysical Abstracts 177-221).

2-2082. Peters, Jack W. GEOPHYSICAL CASE HISTORY OF THE HORSE CREEK FIELD, LARAMIE COUNTY, WYOMING: Geophysics, v. 25, no. 3, p. 602-612, 7 maps, 2 secs., graph, June 1960.

The Horse Creek field in Laramie County, Wyoming, was discovered and developed by the General Petroleum Corp. following a reconnaissance gravity survey and preliminary and detail seismic surveys. The gravity survey, made during 1940, delineated a strong maximum gravity anomaly having a magnitude of about 5 mg. Limited seismic work was then conducted in the area during 1941 and 1942 and mapped a prominent anticline having some 2,000 ft. of closure. In Sept. 1942, General Petroleum Corp. spudded in their No. 78-31-G well, located on the apex of the structure. This well was completed as the discovery for the field, producing from the lower Cretaceous-Lakota sand. The second well, No. 74-6-P, was completed in Apr. 1943, as the lower Cretaceous-Muddy sand discovery for the field. Further seismic work was done during 1944 and 1945 to detail and refine the structural picture. Subsequent drilling developed the Muddy sand as the primary producing zone in this field. A total of 32 producing wells has been drilled on this structure, and to Aug. 1958 the total cumulative production from the field was 3,519,000 barrels of oil.--Auth.

7. GEOCHEMISTRY

See also: Geophysics 2-2071; Mineralogy 2-2094; Igneous and Metamorphic Petrology 2-2107; Fuels 2-2163.

2-2083. Ljunggren, Pontus. DETERMINATION OF MINERALOGICAL TRANSFORMATIONS OF GYPSUM BY DIFFERENTIAL THERMAL ANALYSIS: Am. Ceramic Soc., Jour., v. 43, no. 4, p. 227, fig., Apr. 1960, 3 refs.

On heating gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) from Chiquimula, Guatemala, the following changes were observed: 155°C , $\gamma\text{CaSO}_4 \cdot 2\text{H}_2\text{O} \rightarrow \gamma\text{CaSO}_4 \cdot 0.5\text{H}_2\text{O} + 1.5\text{H}_2\text{O}$; 195°C , $\text{CaSO}_4 \cdot 0.5\text{H}_2\text{O} \rightarrow \gamma\text{CaSO}_4 + 0.5\text{H}_2\text{O}$; 720°C , $\gamma\text{CaSO}_4 \rightarrow \beta\text{CaSO}_4$. These temperatures were observed using a sample 6.5 mm. in diameter, 10 mm. deep, and a heating rate of $11^\circ\text{C}/\text{min}$.

All samples heated to 580°C . or less rehydrated upon treatment with water. The hydration product was $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$. This product passes directly to βCaSO_4 upon heating to approximately 600°C .--F.P. Glasser.

2-2084. Garrels, Robert M., M.E. Thompson, and Raymond Siever. STABILITY OF SOME CARBONATES AT 25°C AND ONE ATMOSPHERE TOTAL PRESSURE: Am. Jour. Sci., v. 258, no. 6, p. 402-

418, 5 figs. incl. diags., graphs, June 1960, 13 refs.

The stabilities of a number of carbonates, both minerals and synthetic compounds, were determined by dissolving them in water saturated with 1 atm. carbon dioxide at 25°C . and 1 atm. total pressure. The pH of the solution was monitored continuously and the equilibrium value determined by extrapolating the pH-time data to infinite time. This equilibrium pH value was used to obtain the standard free energies of formation of the carbonates. The values obtained are listed below and are compared, where data are available, with values listed in U.S. Bureau of Standards Circular 500 or in Latimer's "Oxidation Potentials."--Auth.

2-2085. Khitarov, N.I. ON THE REACTION OF OLIGOCLASE WITH WATER UNDER CONDITIONS OF HIGH TEMPERATURE AND PRESSURE. Translated by Michael Fleischer: Internat. Geology Rev., v. 2, no. 4, p. 322-326, 5 diags., 2 tables, Apr. 1960, 2 refs.

Feldspar group minerals reacting with water at depth determine, by their reaction with environment,

the character of newly formed minerals. Although plagioclase is the most abundant member of this group, experimental data are very limited on the nature of its reactions under high pressure and temperature conditions. The author experimented on acid plagioclase with analytical data and physical constants corresponding to those of oligoclase. The reaction between oligoclase and water was studied under various pressures and temperatures, using a diffusion autoclave. Si, Na, and Al in significant amounts went into solution and smaller amounts of Ca and K were observed. With increased temperature, larger amounts of material constituting oligoclase went into solution. The maximum occurred at 350 to 400°C. and a marked decrease at 500 to 600°C. Quantitative ratios of material in the condensate were found to correspond to albite indices. Increased pressure does not alter this behavior; there is only increased passage of separate components of the mineral into solution. At 350°C., newly formed material was not observed microscopically; at higher temperatures, kaolinite and chalcidony appeared at successively higher temperatures.

Experimentation by Morey and Chen on albite indicate that transfer of the albite component of oligoclase into solution is predominant. By comparison of its stability with that of 2 other minerals, albite is the most reactive with water. At 350°C. and under pressure of 350 kg. per sq. cm., the transfer into solution (in milligrams per liter) is for albite, 318; for microcline, 268; and, for oligoclase, 220. Labradorite was studied under analogous conditions; in that the transfer of labradorite predominates over that of the anorthite molecule, its behavior corresponds to albite.

It was found that basic plagioclase shows less stability than is evident from microscopic examination of plagioclase in rocks. Data from these and previous experiments indicate possible types of solutions that can form within intragranular spaces in rocks by reaction between acid plagioclase and water. It is evident from the data that leaching of the albite component predominates by variation in composition of the solution throughout a wide range of temperature and pressure conditions.--D. D. Fisher.

2-2086. Walton, Matt. MOLECULAR DIFFUSION RATES IN SUPERCRITICAL WATER VAPOR ESTIMATED FROM VISCOSITY DATA: *Am. Jour. Sci.*, v. 258, no. 6, p. 385-401, 5 graphs, table, June 1960, 22 refs.

According to the Stokes-Einstein equation the diffusivity of a particle in a gas is a function of the radius of the particle, the absolute temperature, and the viscosity of the gas. Recent theoretical and experimental results are used to extrapolate values for the viscosity of supercritical water vapor up to 800°C. and 2,500 kg. cm.⁻² pressure. The function Dr_g is evaluated in this range, where D is diffusivity and r_g the radius of a molecular particle in solution in supercritical water vapor. It is shown that molecular components of rocks should have diffusion rates on the order of 10^{-3} to 10^{-4} cm.²sec.⁻¹ over a wide range of geologic pressures and temperatures. As an example, these results are applied to an evaluation of the diffusivity of silica in supercritical water vapor, and it is shown that the mass transport of silica by diffusion is potentially a relatively rapid geologic process where supercritical water vapor exists at high pressures in the intergranular spaces in rocks, even where the effective directional porosity of the rock is several orders of magnitude less

than one. Values for viscosity of water, Dr_g , solubility in water of SiO_2 in gm. cm.⁻³, mass transport of SiO_2 , and mean square displacement of SiO_2 in supercritical water vapor are given graphically for various temperatures up to 800°C. and pressures up to 2,500 kg. cm.⁻².--Auth.

2-2087. Yavnel, A. A., and M. I. Dyakonova. THE CHEMICAL COMPOSITION OF METEORITES. Translated by Royer and Roger, Inc.: *Internat. Geology Rev.*, v. 2, no. 4, p. 298-310, 7 tables, Apr. 1960, 26 refs.

At present, investigations on the chemical composition of meteoritic matter are being made in 2 directions: 1) the determination of the main constituents of meteorites of different classes. (A generalization of these data led to the classification of meteorites depending on their chemical composition); 2) the determination of all the element contents including small admixtures in meteoritic matter according to their phases: metallic, silicate, and also in accessory minerals.

A review of all data on the composition of meteorites ensures the systematic study of their mineral content, structure, and other properties and makes possible a closer approach to the solution of their origin.

As a result of a critical review of existing general investigations and separate data concerning the contents of the basic constituents of meteorites, the composition of each subclass divided into families according to groups is given in the tables.

Changes in the composition of meteorites of each group while passing from one subclass to another are clearly seen in the tables, and this allows an opinion to be formed on the laminated planetary bodies from which the meteorites were formed.

The contents of all the chemical elements found in meteoritic matter are given in tables. The results of recently published works have been taken into account, and old data have been reconsidered.--From English supp. to *Meteoritika*.

2-2088. Yavnel, A. A. CLASSIFICATION OF METEORITES ACCORDING TO THEIR CHEMICAL COMPOSITION. Translated by Royer and Roger, Inc.: *Internat. Geology Rev.*, v. 2, no. 5, p. 380-396, 3 diags., 6 graphs, table, May 1960, 20 refs.

Consideration of the main principles of classification of meteorites leads to the conclusion that the primary characteristic should be their chemical composition. From this point of view, the most correct classification was formulated by Prior; however, it needs further perfection.

Definite properties were formed in the chemical composition of meteorites of all 3 classes. This enabled us to divide the classes into 6 subclasses: Carich achondrites, Ca-poor achondrites, chondrites, siderolites (mesosiderites), lithosiderites (pallasites), and siderites. These differ in their total Fe content, indicated in the ratio of silicate to metallic phase. Depending on the principal composition of the phase (the content of FeO in silicates and Ni in metal), the meteorites are divided into 5 groups, evidently related to the separate generative bodies.

This distribution is of a distinct character, reflects the genetic connections between different types of meteorites, and can serve as a basis for their classification. Mineralogical and structural properties were taken into account, and a scheme for classification of meteorites according to their chemical-mineralogical composition and structure elaborated.

An interconnection has been found between the quantity of FeO in silicates and the content and composition of Ni-Fe in chondrites, mesosiderites, and palasites; this is called Prior's group law, as it is observed if meteorites of different groups are com-

pared and absent inside the group itself. It is concluded that the above law characterizes processes that took place before matter broke up into groups; i. e. before the formation of bodies from which meteorites originated.--Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Sedimentary Petrology 2-2108, 2-2111.

2-2089. Spiroff, Kiril. SEAMAN'S MINERAL TABLES: 84 p., diags., tables, Houghton, Michigan, Michigan College of Mining and Technology Press, 1959.

These are tables of mineral characteristics designed for the mineralogy student as a supplement to Dana's Textbook of Mineralogy. Although it is primarily a collection of data, space is left for notes and sketches to be made by the student. Text discussion covers cleavage, crystallography, crystal axes and Miller indices, hardness, specific gravity, luster, color, streak, taste, feel or touch, magnetism, fracture, tenacity, odor, crystalline habit and crystalline aggregates, and chemistry. The tables list minerals on the basis of number of cleavage directions, crystal habit, luster, streak, taste; also fibrous, and nodular-earthy types.--M. Russell.

2-2090. Clark, R.H., and W.J. Clarke. A PLASTIC UNIVERSAL STAGE FOR STUDENT USE: Am. Mineralogist, v. 45, no. 1/2, p. 224-228, 2 illus., Jan.-Feb. 1960.

This 3-axis stage is produced for \$25. from easily machined plastic sheets, brass bearings, and wire polished soda glass hemispheres. Reasonably accurate, direct measurements of 2V are possible using this stage on a student model microscope with an objective of about 4 power.--D.O. Emerson.

2-2091. Giardini, A.A., J.E. Tydings, and S. Benedict Levin. A VERY HIGH PRESSURE-HIGH TEMPERATURE RESEARCH APPARATUS AND THE SYNTHESIS OF DIAMOND: Am. Mineralogist, v. 45, no. 1/2, p. 217-221, 2 illus., diag., Jan.-Feb. 1960, 7 refs.

With the high pressure cemented carbide piston supported by a compressible ring of machined pyrophyllite it is possible to reproduce sustained near-hydrostatic pressures of 100,000 atm. concurrent with temperatures exceeding 3,000°C. Yellow diamond crystals were produced from a Ni-graphite mixture in the electrical resistance tube at 85,000 atm. and 1,560°C.--D.O. Emerson.

2-2092. Sharp, W.E. THE CELL CONSTANTS OF ARTIFICIAL SIDERITE: Am. Mineralogist, v. 45, no. 1/2, p. 241-243, table, Jan.-Feb. 1960, 4 refs.

NaHCO₃, FeSO₄·7H₂O, H₂O, and CO₂ were held at 200°C. and 500 bars for 3 days to prepare a white FeCO₃ precipitate. This was dried and heated at 500°C. at 15 kb. pressure. Lattice constants of this artificial siderite compare closely with natural material.--D.O. Emerson.

2-2093. Christ, C.L., and Joan R. Clark. X-RAY CRYSTALLOGRAPHY AND CRYSTAL CHEMISTRY

OF GOWERITE, CaO·3B₂O₃·5H₂O: Am. Mineralogist, v. 45, no. 1/2, p. 230-234, table, Jan.-Feb. 1960, 6 refs.

X-ray powder data and unit cell dimensions are given for the new mineral gowerite. The structure may consist of either single or polymerized [B₃O₃(OH)₄]⁻¹ polyions.--D.O. Emerson.

2-2094. Perloff, A., and Stanley Block. LOW TEMPERATURE PHASE TRANSITION OF COLEMANITE: Am. Mineralogist, v. 45, no. 1/2, p. 229, Jan.-Feb. 1960, 5 refs.

Diffraction photographs of the h0l and 0kl reciprocal lattice nets at room temperature and -30°C. show no cell dimension changes. Very weak reflections establish a reversible transition from the room temperature P₂/a phase to a low temperature P₂l phase.--D.O. Emerson.

2-2095. Lodding, William. VERMICULAR GIBBSITE IN THE PENSACULA OF NEW JERSEY: Am. Mineralogist, v. 45, no. 1/2, p. 228-229, Jan.-Feb. 1960, ref.

Vermiform gibbsite grains about 1 mm. long occur in coarse gravel of the Pensacola formation [Pleistocene] near South River, New Jersey.--D.O. Emerson.

2-2096. Ljunggren, Pontus. TODOROKITE AND PYROLUSITE FROM VERMLANDS TABERG, SWEDEN: Am. Mineralogist, v. 45, no. 1/2, p. 235-238, fig., table, Jan.-Feb. 1960, 7 refs.

Todorokite and pyrolusite with unusually low trace element content occur as manganiferous veins and impregnations in the soft Fe ore of western Sweden. The Mn probably was derived from altering wall rock and was deposited during a late phase of the alteration. The low permeability of the argillaceous wall rock prevented subsequent contamination by trace elements. DTA and X-ray powder data are given for these minerals.--D.O. Emerson.

2-2097. Sahama, Th.G. IDENTITY OF CALCIUM RINKITE AND GÖTZENITE: Am. Mineralogist, v. 45, no. 1/2, p. 221-224, table, Jan.-Feb. 1960, 6 refs.

Physical, chemical, and structural data show calcium rinkite and götzenite to be the same species. The name calcium rinkite should be dropped. A new unit cell for götzenite: a = 9.65, b = 7.32, c = 5.74, α = 90°, β = 101.3°, γ = 101.1°, should be adopted.--D.O. Emerson.

2-2098. Hinckley, David N. and Thomas F. Bates. AN X-RAY FLUORESCENCE METHOD FOR THE QUANTITATIVE DETERMINATION OF SMALL AMOUNTS OF MONTMORILLONITE IN KAOLIN

CLAYS: *Am. Mineralogist*, v. 45, no. 1/2, p. 239-241, diag., Jan.-Feb. 1960.

By exchanging Sr^{++} onto the montmorillonite, removing the excess Sr by dialysis, analyzing the exchanged sample for Sr by X-ray fluorescence, and computing the percentage of montmorillonite from these results according to a curve derived from similarly prepared known standards, unknowns can be determined with a precision of $\pm 0.5\%$ in the 0.5-8% range.--D. O. Emerson.

2-2099. Ormsby, W. C., and J. M. Shartsis. CLAY MINERAL CONTENT OF TWO DOMESTIC KAOLINS: *Am. Ceramic Soc., Jour.*, v. 43, no. 6, p. 335, table, June 1960, 5 refs.

A detailed study of the mineralogical constitution of 2 domestic clays was made in an effort to find material suitable for rheological studies. The compositions of controlled particle size fractions of these clays were studied by conventional methods. One clay (Georgia) was found to contain significant amounts of montmorillonite, whereas the other clay (Florida) was, with the exception of a micaceous contaminant, practically monomineralic (kaolinite). Most of the micaceous mineral present in the Florida clay separated out in the coarse fraction ($44/10\mu$), making it possible to collect a series of nearly monomineralic fractions below 10μ .--Auth.

2-2100. Smoot, Thomas W. CLAY MINERALOGY OF PRE-PENNSYLVANIAN SANDSTONES AND SHALES OF THE ILLINOIS BASIN. PART III.-CLAY MINERALS OF VARIOUS FACIES OF SOME CHESTER FORMATIONS: *Illinois State Geol. Survey, Circ.* 293, 19 p., 6 maps, diag., 1960, 15 refs.

Clay mineral suites of approximately contemporaneous sandstone and shale deposits were studied to determine whether their differences were such that clay minerals could be used in the determination of the environment of deposition of sediments. Differences were noted to be present. Suites from the sandstones were found to be divisible into 2 facies, the high-kaolinite and the low-kaolinite. Two facies also were generally discernible in the shales, the illite and the mixed-layer facies. The illite facies in shales and the low-kaolinite facies of sandstones both represent sediments deposited farther from shore than the sediments represented by the high-kaolinite sandstone facies and mixed-layer shale facies.

Differences in clay minerals other than kaolinite are due in part to alterations that occur in them during and soon after deposition, and these alterations are functions of rate of deposition and/or water composition. The investigation indicates that kaolinite is concentrated near the shore.

Clay mineral facies in several stratigraphic units are mapped, using ratios of the several minerals to each other. These maps conform in a general way to environmental facies charts.--Auth.

2-2101. Morrill, Philip, and others. MAINE MINES AND MINERALS. VOL. 1. WESTERN MAINE. VOL. 2. EASTERN MAINE: 2 v., 41 maps, Naples, Maine, Dillingham Natural History Museum, 1958, 1959.

A listing, without explanatory text, of known mines and mineral occurrences in Maine. Brief annotations on accessibility, present operations, and peculiarities of the minerals are given. A minerals list and locality maps are included.--M. Russell.

9. IGNEOUS AND METAMORPHIC PETROLOGY

2-2102. Engle, Eloise. MEN ON THE MOUNTAIN: *Natl. Parks Mag.*, v. 34, no. 148, p. 4-6, 7 illus., map, Jan. 1960.

A popular account of the activities of the U. S. Geological Survey team at volcano observatory at Kilauea on the island of Hawaii. Its staff makes continuous geochemical and geophysical observations of volcanic activity in the area; tiltmeter and seismograph readings are providing possible means to predict volcanic eruptions. Incidences and details of 1949, 1950, and 1955 eruptions are described.--M. Russell.

2-2103. Murata, K. J. DIARY OF A VOLCANO: *Natl. Parks Mag.*, v. 34, no. 148, p. 12-13, table, Jan. 1960.

Details are given of the changes in volcanic activity at Kilauea Iki, Hawaii, from Nov. 19 through Dec. 14, 1959, as recorded from letters and telegrams sent to the Washington office of the U. S. Geological Survey.--M. Russell.

2-2104. Kilgore, Bruce M. KILAUEA IKI GOES ISLAND BUILDING: *Natl. Parks Mag.*, v. 34, no. 148, p. 7-8, map, Jan. 1960.

Tiltmeter and seismograph readings indicated imminent volcanic activity which actually started on Nov. 14, 1959, in Kilauea Iki crater, Hawaii. Twelve lava fountains erupted from a rift 300 yds. long and spilled like a waterfall to the crater pit 400 ft. lower.

Later all activity was from one fountain which at times reached 1,700 ft., a record for Hawaiian lava fountains. By Nov. 21, Kilauea Iki crater was estimated to contain over 40 million cu. yds. of lava in a pool 350 ft. deep. By early Dec. the pool depth was 400 ft.--M. Russell.

2-2105. DESTRUCTION ON KILAUEA'S LOWER SLOPES: *Natl. Parks Mag.*, v. 34, no. 149, p. 14, 19, illus., map, Feb. 1960.

After activity had ceased on Dec. 19, 1959, at Kilauea Iki crater, Hawaii, unusual doming was recorded in the dome of Kilauea, indicating renewed eruptions. Earthquake swarms were recorded on Jan. 11 and 12, 1960. On Jan. 13 a rift opened near Kapoho village at the E. end of Hawaii island, and within a few hours lava poured out. By Jan. 15 it had cut a 3-mi. swath to the sea.--M. Russell.

2-2106. McTaggart, Kenneth C. THE MOBILITY OF NUÉES ARDENTES: *Am. Jour. Sci.*, v. 258, no. 5, p. 369-382, 2 diags., profile, 2 graphs, May 1960, 20 refs.

Nuées ardentes, the hot clouds characteristic of Peléan eruptions, carry and deposit tremendous loads of fragmental volcanic rock. Blocks several meters across may be carried for 25 km. on slopes of about 10° . According to the generally accepted gas-emission hypothesis, the blocks of lava are sup-

ed by volatiles emitted from their bases during transport. Calculations suggest, however, that this mechanism would not be effective, and further, by this mechanism, large blocks should travel farther than small ones, resulting in size-sorting with respect to the source. Such distribution has been reported. Experiments with hot and cold air suggest that the mobility of nuées ardentes is due to extreme internal turbulence caused by envelopment of cold air by hot fragmental debris.--Auth.

107. Chao, Tsung-pu. PETROCHEMICAL ANALYSIS OF THE CENOZOIC BASALTIC ROCKS IN EASTERN CHINA. Translated by Edward C.T. Chao. *Internat. Geology Rev.*, v. 2, no. 3, p. 196-217, March 1960; no. 4, p. 273-297, Apr. 1960, map, 20 plates, 17 tables, 92 refs.

Cenozoic basalt lavas are widely distributed in the coastal region and adjacent districts in eastern China. They form either widespread plateaus or isolated mesas; in some places, the volcanic craters are well preserved. These basalt sheets were erupted from multiple vents in the late Tertiary and

early Quaternary.

The results of a petrochemical study of the Cenozoic basalt in eastern China are given. The most characteristic feature of the more basaltic rocks is their high K_2O content, also the undersaturation in silica. In N. China and S. Manchuria most basalts are trachybasalts and occasional nepheline basalt. The constituent minerals of these basalts are anorthoclase, potash-andesine, plagioclase, titanite, and abundant olivine. In S. China the main basalt is olivine basalt, consisting of olivine, augite, and plagioclase. At some places the basalt may be slightly silica saturated, and the occasional presence of hypersthene and quartz (xenocryst) is noteworthy. In N. Manchuria the dominant basalt is leucite basalt, containing leucite and olivine as phenocryst and ground-mass constituents. Xenocrysts of quartz and feldspar are sometimes present. In Taiwan province, the basalt of Kuan-yin-shan (volcano) is of the tholeiite type, but, in some other districts, the alkaline basalt with feldspathoidal constituent also occurs.

The petrographical difference seems to be matched by the differences of the major tectonic forms of China.--From "General Sketch" of auth. English résumé.

10. SEDIMENTARY PETROLOGY

Also: Areal and Regional Geology 2-1968; Geophysics 2-2069; Mineralogy 2-2100.

108. Hay, Richard L. RATE OF CLAY FORMATION AND MINERAL ALTERATION IN A 4000-YEAR-OLD VOLCANIC ASH SOIL ON ST. VINCENT, B.W.I.: *Am. Jour. Sci.*, v. 258, no. 5, p. 354-368, map, 2 graphs, May 1960, 23 refs.

The surface of a large fan of pyroclastic deposits erupted about 4,000 years ago has weathered to a grey soil generally 6 ft. thick. The weathered deposits were originally andesitic ash consisting largely of glass and the minerals anorthite, labradorite, hypersthene, augite, and olivine. Fine vitric ash has altered to halloysite $\cdot 4H_2O$, allophane, and hydrated ferric oxide. The vitric lapilli have decomposed to halloysite $\cdot 4H_2O$. Anorthite crystals are etched in the soil and frosted in the underlying ash. Hypersthene and fewer augite and olivine crystals in the soil are etched. Labradorite, hornblende, and magnetite are unaltered.

The 4,000-year-old soil represents an early stage in the formation of the Yellow Earth soils of St. Vincent, which may themselves be classified with the low-brown volcanic-ash soils of Japan. Halloysite $\cdot 4H_2O$ has been redeposited in some late Pleistocene beds on St. Vincent to form dark brown, waxlike gleys. Whether or not the yellow-brown volcanic soils of St. Vincent represent an early state in the formation of a lateritic red soil cannot be demonstrated.

Clayey soil formed from ash at an average rate of 1/2-2 ft./1,000 years on St. Vincent, and glass composed at a rate of about 15 gm./cm.²/1,000 yrs. The slight degree to which the unstable minerals anorthite, olivine, and the pyroxenes are altered contrasts sharply with the decomposition of glass. Survey of the literature suggests that minerals have altered more rapidly in some podzols of the temperate regions than in the volcanic soils of St. Vincent. This contrast in weathering may perhaps be explained by the low pH of podzols and chemical effect of the rapidly decomposing

glass of the ash soils.--Auth.

2-2109. Crook, Keith A.W. CLASSIFICATION OF ARENITES: *Am. Jour. Sci.*, v. 258, no. 6, p. 419-428, 7 diags., June 1960, 10 refs.

A critical examination of the classificatory schemes of Pettijohn, Gilbert, Packham, and Folk leads to the conclusion that only Packham's, which uses sedimentary structures as a parameter, is validly based genetically. Packham's scheme is expanded by the introduction of a generalized, nongenic, 'arenite' diagram which is congruent with the genetic graywacke and arkose-quartzose sandstone (here termed simply 'sandstone') diagrams and which enables it to deal with arenites when data on sedimentary structures are not available.

A new QFR diagram is introduced having quartz, feldspar, and rock fragments plus other labiles as parameters. The nongenic classes of labile arenites recognized are feldspathic, lithofeldspathic, feldspatholithic, and lithic. Congruent graywacke and sandstone QFR diagrams may be employed where appropriate. Two classes of sublabe arenite are recognized - feldspathic sublabe arenite and lithic sublabe arenite. The term 'arenite' may again be replaced by 'sandstone' or 'graywacke' where appropriate. The use of 'feldspathic sandstone/arenite/wacke' as descriptive of sublabe arenites should be discontinued.--Auth.

2-2110. Kuenen, Philip H. SAND: *Sci. American*, v. 202, no. 4, p. 94-106, 109-110, Apr. 1960.

Geologists define sand as particles of rock between .05 and 2.0 mm. in diameter. The shape of sand grains, transported by water and wind, is a clue to their history. Chemical disintegration is as important in the origin of sand as mechanical disintegration. Water is a prime agent of transportation of sand but is not so important a factor in rounding of grains as is wind. Turbidity currents explain the presence of many sand deposits on the ocean floor.

Much of the present sand has undergone several cycles of erosion and deposition.--M. Russell.

2-2111. Kerr, Paul F. SALINE DEPOSITION IN THE GREAT BASIN. A PRELIMINARY LITERATURE SUMMARY: 126 p., 12 illus., 16 maps, chart, 4 secs., 2 diags., 37 tables, New York, Columbia University, Dept. of Geology, 1959, approx. 200 refs.

The first unit of a sequence of literature surveys to be supplemented by field observations which will constitute the Salines Project. The major objective of the project is to extract from the literature data which affect the mineralogy of salines. This involves first an examination of the geological conditions which

affect accumulation. To accomplish this end, saline basins, both ancient and modern, will receive attention. This will be followed by specific consideration of the mineral aggregates involved and the conditions which affect their accumulation. In order to maintain a productive sequence, the survey will be made selective rather than exhaustive. More attention will be given to classic and outstanding references and less attention to numerous references of minor consequence.--From p. 8.

Areas covered are: Bonneville basin; Great Salt Lake; Lake County, Oregon; Lahontan basin; southwestern basins - Mono Lake, Mono basin thiolite, Rhodes marsh, Owens Lake, Searles Lake, Panamint Valley, Death Valley area, Boron, and Salton Sea.

II. GEOHYDROLOGY

See also: Geophysics 2-2078; Mineral Deposits 2-2148.

2-2112. LET'S PROTECT THE WATER UNDER THE GROUND: Water Well Jour., v. 14, no. 5, p. 28-29, 48, 52, 54-56, 2 illus., sec., May 1960.

Pollution of ground water is the result, generally, of one of the following situations: 1) waste water may enter the water-bearing formation through relatively open channels, such as drainage wells, without the beneficial effect of percolation and filtration through soil materials; 2) waste liquids that contain chemical substances which are not removed by percolation may be allowed to seep through the ground; 3) ordinary sewage may be disposed of at or near the surface in quantities so great as to overtax the natural purifying capacity of the ground. The first priority in needed control and correction is to reduce pollution by providing sewerage.--M. Russell.

2-2113. Nace, R. L. WATER MANAGEMENT, AGRICULTURE, AND GROUND-WATER SUPPLIES: U.S. Geol. Survey, Circ. 415, 12 p., map, diag., 2 graphs, 2 tables, 1960, 8 refs.

Encyclopedic data on world geography strikingly illustrate the drastic inequity in the distribution of the world's water supply. About 97% of the total volume of water is in the world's oceans. The area of continents and islands not under icecaps, glaciers, lakes, and inland seas is about 57.5 million sq. mi. of which 18 million (36%) is arid to semiarid.

The total world supply of water is about 326.5 million cu. mi., of which about 317 million is in the oceans and about 9.4 million is in the land areas. Atmospheric moisture is equivalent to only about 3,100 cu. mi. of water.

The available and accessible supply of ground water in the United States is somewhat more than 53,000 cu. mi. (about 180 billion acre-ft.). The amount of fresh water on the land areas of the world at any one time is roughly 30,300 cu. mi., and more than a fourth of this is in large fresh-water lakes on the North American continent.

Annual recharge of ground water in the United States may average somewhat more than 1 billion acre-ft. yearly, but the total volume of ground water in storage is equivalent to all the recharge in about the last 160 years. This accumulation of ground water is the nation's only reserve water resource, but already it is being withdrawn or mined on a large scale in a few areas.

The principal withdrawals of water in the United

States are for agriculture and industry. Only 7.4% of agricultural land is irrigated, however, so natural soil moisture is the principal source of agricultural water, and on that basis agriculture is incomparably the largest water user. In view of current forecasts of population and industrial expansion, new commitments of water for agriculture should be scrutinized very closely, and thorough justification should be required. The 17 western states no longer contain all the large irrigation developments. Nearly 10% of the irrigated area is in states E. of the western bloc, chiefly in several southeastern states.

Ground water is not completely "self-renewing" because, where it is being mined, the reserve is being diminished, and the reserve would be renewed only if pumping were stopped.

Water is being mined at the rate of 5 million acre-ft. per year in Arizona and 6 million in the High Plains of Texas. In contrast, water has been going into storage in the Snake River plain of Idaho, where deep percolation from surface-water irrigation has added about 10 million acre-ft. of storage since irrigation began.

Situations in California illustrate problems of land subsidence resulting from pumping and use of water and deterioration of ground-water reservoirs due to sea-water invasion.

Much water development in the United States has been haphazard, and rarely has there been integrated development of ground water and surface water. Competition is sharpening, and new codes of water law are in the making. New laws, however, will not prevent the consequences of bad management. An important task for water management is to recognize the contingencies that may arise in the future and to prepare for them. The 3 most important tasks are to make more efficient use of water, to develop improved quantitative evaluations of water supplies and their quality, and to develop management practices which are based on scientific hydrology.--Auth.

2-2114. Arizona, University, Rillito Creek Hydrologic Research Committee and U.S. Geological Survey. CAPTURING ADDITIONAL WATER IN THE TUCSON AREA: U.S. Geol. Survey, Repts., Open-File Ser., 59 p., 18 figs. (2 in pocket) incl. illus., maps, graphs, 6 tables, June 1959, 26 refs.

A preliminary study on the possibilities of increasing available water supplies within the Tucson basin to meet the anticipated water demand resulting from the rapid increase in population.

The Tucson basin is a depressed structural block between the surrounding mountain masses. The impermeable Pantano beds and the crystalline complex compose the mountain masses and form the margin floor of the ground-water basin. The sediments which constitute the actual ground-water reservoir of 3 principal types: 1) alluvial deposits of the basin, which underlie most of the broad, locally flat floor of the valley; 2) the inner-valley fill, which underlies the flood plains of the major rivers; and 3) the alluvial-fan deposits along the mountain fronts. The thickness and general configuration of the inner-valley fill and the fan deposits are fairly well known; however, the thickness of the deposits of the Tucson basin, the main source of ground water, is not certain, and their relationship to the adjacent and underlying Pantano beds and crystalline complex is one of the principal problems requiring investigation.

Until disturbed by man, the amount of water in storage in the sediments of the Tucson basin remained almost constant. In recent years, however, water has been withdrawn from the basin much faster than it has been replenished by rainfall and runoff; consequently, static water levels have declined as much as 35 ft., and net ground-water storage loss has been estimated as 250,000 acre-ft. during the past 12 years. It is apparent that ground-water supplies will become depleted unless measures are taken to replenish the amount in storage.

The runoff potential in Rillito Creek is equal to that of the amount of water used in the greater Tucson area. Much of this incoming water is lost before it can be used, as the potential evaporation is about 1.5 times the annual precipitation, and vegetation along stream channels uses an estimated 2,500 acre-ft. per year. Moreover, runoff leaving the Rillito Creek is on an average about 12,000 acre-ft. per year. It is believed that additional water, which is now lost by evaporation or outflow from the basin via Rillito Creek during the rainy season, could be captured. Salvage of this water would ease the pressure on the ground-water reserves, through transfer into the distribution system and recharge into the subsurface, where the ground-water reservoir has been locally depleted.

A review of present knowledge of salient features of the Tucson basin indicates the need for further studies along several lines - the pattern of precipitation throughout the basin, amounts and distribution of runoff, quality of both surface and ground water, amount of water lost by evaporation and transpiration, amount of ground water in storage and its movement within the basin, and the feasibility of artificial recharge of the ground-water reservoir.--Auth.

2-2115. Wait, Robert L. SOURCE AND QUALITY OF GROUND WATER IN SOUTHWESTERN GEORGIA: Georgia, Dept. Mines, Mining & Geology, Inf. Circ. 174 p., 3 maps, graph, 4 tables, 1960, 14 refs.

Ground water of excellent quality may be obtained throughout southwestern Georgia. The water from Tertiary formations is chiefly of the calcium bicarbonate type and is moderately hard to very hard and alkaline. That from the Upper Cretaceous rocks is of the sodium bicarbonate type and is soft and slightly alkaline. Dissolved solids are usually moderate and consist mostly of Ca or Na and bicarbonate. Ground water from the Ocala limestone usually is of the sulfate type and is of moderate hardness. In sulfate near the area of outcrop, but the sulfate increases downdip and in the Valdosta area sulfate is reported to be extremely high. In the vicinity

of the Withlacoochee anticline near Thomasville water from a depth of about 1,600 ft. was too saline for most uses. The temperature of ground waters in the area ranged from 67° to 77°F.

The quality of ground water in southwestern Georgia is generally suitable for municipal, industrial, and irrigational uses of the water, though some softening of the very hard waters is desirable for domestic uses.--Auth. concl.

2-2116. Hackett, James E. GROUND-WATER GEOLOGY OF WINNEBAGO COUNTY, ILLINOIS: Illinois State Geol. Survey, Rept. Inv. 213, 63 p., 8 maps (1 in pocket), secs. (1 in pocket), graphs, 1960, 39 refs.

The geology of Winnebago County was studied to determine its relation to the occurrence and availability of ground-water supplies in the area.

Eleven bedrock formations, Precambrian, Cambrian, and Ordovician in age, are present. Glacial drift deposited during the Farmdale and Shelbyville ice advances of Wisconsin age overlies the bedrock, and the deeply cut bedrock valleys contain thick deposits of glacial outwash.

Four geohydrologic units were noted: the glacial drift aquifers of Pleistocene age; the dolomite aquifers of Ordovician age (the Galena, Decorah, and Platteville formations, and the upper part of the Glenwood); the sandstone aquifers of Ordovician age (the St. Peter and the lower part of the Glenwood formation); and the sandstone aquifers of Cambrian age (the Ironston-Galesville and Mt. Simon and the lower part of the Eau Claire formation).

The Cambrian aquifers and the thick glacial outwash in the bedrock valleys are the main sources of water in the county, and both are capable of supplying considerably more water than they do at present. They serve the large industries and municipalities, whereas the sandstone aquifers of Ordovician age supply the smaller industries and cities. Water from the dolomite aquifers is used principally for domestic and stock supplies.

Maps and figures show the distribution and position of the rock types, buried valleys, and the availability of ground water from glacial drift.--Auth.

2-2117. Walton, William C., Robert T. Sasman, and R.R. Russell. WATER LEVEL DECLINE AND PUMPAGE DURING 1959 IN DEEP WELLS IN THE CHICAGO REGION, ILLINOIS: Illinois State Water Survey, Circ. 79, 39 p., 4 maps, 4 secs., 19 graphs, 6 tables, 1960, ref.

The water-level decline during 1959 in deep wells penetrating the Cambrian-Ordovician aquifer, the most highly developed aquifer for large ground-water supplies in the Chicago region, is considered. The Cambrian-Ordovician aquifer is encountered at an average depth of about 500 ft. below the land surface at Chicago; it has an average thickness of 1,000 ft. and is composed chiefly of sandstones and dolomites.

Pumpage from deep wells has increased from 200,000 gallons per day (g. p. d.) in 1864 to 78.3 million gallons per day (m. g. d.) in 1958 (as reevaluated in 1960). As a result, artesian pressure in the Cambrian-Ordovician aquifer at Chicago has declined 660 ft. Pumpage from deep wells is concentrated in 6 centers: Chicago area, Joliet area, Elmhurst area, Des Plaines area, Aurora area, and Elgin area.

In 1959, pumpage from deep wells was 88.0 m. g. d. or 9.7 m. g. d. more than in 1958. This annual increase in pumpage is record high and has

resulted in excessive declines in water levels in deep wells. Water-level declines during 1959 ranged from 9 ft. in the Joliet area to 41 ft. in the Elmhurst area and averaged about 20 ft. The 1959 average decline is much greater than the average annual rate of decline (10 ft.) for the period 1945-1958.

Withdrawals in 1959 exceed the practical sustained yield of the Cambrian-Ordovician aquifer, with the result that ground-water users in the Chicago region have started to mine water and to borrow water from future generations. If the distribution of pumpage remains the same as in 1959 and pumpage from the Cambrian-Ordovician aquifer continues to increase in the future, the lowest and most permeable unit of the aquifer will be partially dewatered in many areas much sooner than previously anticipated. Pumping levels exceeding 1,000 ft. below the surface will be common within 20 years.--Auth. summ.

2-2118. Suter, Max. ARTIFICIAL GROUND WATER RECHARGE AT PEORIA, ILLINOIS: Illinois State Acad. Sci., Trans., v. 52, no. 3/4, p. 96-99, secs., graph, 1959, pub. 1960.

To counter the effect of overpumping ground water in the Peoria area, a recharge program was initiated. Results of this program indicate that much higher recharge rates can be obtained from pits with large areas of steeply sloping slides than with pits having low slopes and large flat bottom areas. It was also found that effective filtering action with high recharge rates can be obtained with the use of 3/8 in. gravel rather than 1 mm. size sand.--M. Russell.

2-2119. Grove, Arthur M. THE STRATIGRAPHY OF THE CITY WELLS AND THE PROBLEMS OF WATER DISTRIBUTION AT MANKATO: Minnesota Acad. Sci., Proc., v. 25/26, p. 355-359, table, 1957/1958, pub. 1960, 2 refs.

An abundance of water is available for domestic and industrial uses in Mankato. Wells sunk into the alluvium of the river valley and into the sandstone underlying the lower terraces can be artesian. Wells sunk from the plain outside the city are not. The water is odorless, colorless, and has no objectionable taste. It is extremely hard, making water softening necessary, and it does tend to be corrosive. Some early wells have been abandoned because of the small size of their bore. A switch from steam power to electric power has caused a number to be capped. The growing popularity of air conditioning has resulted in the digging of several new ones.--Auth. concl.

2-2120. Jablonski, Leo A. RECORDS OF WELLS AND GROUND-WATER QUALITY IN MONMOUTH COUNTY, NEW JERSEY, A PRELIMINARY REPORT: New Jersey, Dept. Conserv. & Econ. Devel., Div. Water Policy & Supply, Water Resources Circ. 2, 47 p., map (in pocket), 3 tables, 1959, 3 refs.

This preliminary report presents the ground-water data currently tabulated and evaluated for Monmouth County, with special emphasis on domestic wells. Generalized geologic correlations are given, based on field determination of the lithology. In one table are given geologic age, thickness, and water-bearing properties of the formations. In another table are given the chemical analyses of water samples from 31 wells. Ground water in New Jersey generally contains 1/10 of 1% by weight or less of dissolved mineral matter. Analyses show: SiO_2 ,

trace to 45 p.p.m.; Fe, 0 to 33 p.p.m.; Ca, 1. / to 40 p.p.m.; Mg, 0.3 to 15 p.p.m.; Na, 1.0 to 18 p.p.m.; K, 1.4 to 4.2 p.p.m.; HCO_3 , 0 to 128 p.p.m.; SO_4 , less than 33 p.p.m.; Cl, mostly less than 9 p.p.m.; F, 0.6 p.p.m. or less; NO_3 , mostly less than 1 p.p.m.; H_2S , common in water from Kirkwood formation; dissolved solids, 21 to 437 p.p.m.; specific conductance, 40 to 360 micromhos; hardness, 4 to 260 p.p.m.; pH, 3.9 to 8.9.--M. Russell.

2-2121. Doty, Gene C. RECONNAISSANCE OF GROUND WATER IN PLAYAS VALLEY, HIDALGO COUNTY, NEW MEXICO: New Mexico, State Engineer Office, Tech. Rept. 15, 40 p., 10 figs. incl. 4 illus., 2 maps (1 fold.), graph, 7 tables, 1960, 15 refs.

Playas Valley is a N.-trending intermontane valley in the Basin and Range province of southwestern New Mexico. A reconnaissance investigation of the area was made by the U.S. Geological Survey in cooperation with the State Engineer of New Mexico to determine the availability of water throughout the valley. The area investigated is 925 sq. mi. in southern Hidalgo County, comprising Tps. 26-34 S., Rs. 16-18 W. It includes the Playas Valley underground water basin, 515 sq. mi. in extent.

The rolling plain of the valley floor is bordered by the Big and Little Hachet mountains on the E. and the Animas and Pyramid mountains on the W. An inconspicuous alluvial divide extends across the valley from Gillespie Mountain on the W. to a point just north of Hachet Gap on the E. and separates upper (southern) from lower (northern) Playas Valley. Surface runoff in upper Playas Valley collects along the E. side of the valley in an almost flat area that drains northward to Hachet Gap, then eastward into Hachita Valley; lower Playas Valley drains toward ephemeral Playas Lake about 2 mi. S. of a line of the Southern Pacific Co. and is a closed basin topographically.

Until recently, the arid to semiarid climate has discouraged farming. In 1948, however, successful irrigation with ground water began in secs. 16 and 21, T. 30 S., R. 16 W. In late 1955 and early 1956, a series of test holes and 2 irrigation wells were drilled on the U-Bar Ranch property in the southern part of upper Playas Valley to provide data for an evaluation of the ground-water resources. Conversion of 20 to 35 sections of the U-Bar Ranch property into irrigated farmland was contemplated. The area was surveyed and some of the land was sold or placed under purchase option. The Playas Valley underground water basin was declared on February 23, 1956, by order of the State Engineer of New Mexico.

Playas Valley is a sediment-filled trough created by block faulting. Much of the valley fill, which is composed of detritus of unknown thickness accumulated from the erosion of the surrounding highlands, is saturated with ground water. The water table lies about 200 ft. below the land surface at the southern end of the valley and only a few feet below the surface near Playas Lake. From near the Mexican border to the vicinity of Hachet Gap, the water table slopes at a gradient of about 7 ft. per mi. The gradient flattens near Playas Lake. Wells yield water under artesian pressure in parts of the valley, and flowing wells have been drilled along the W. side of Playas Lake and at Las Cienegas.

Recharge to the body of ground water in Playas Valley is derived from precipitation on the valley and its drainage area. Recharge is only a small percentage of the total precipitation because of losses

evapotranspiration and runoff and because of the relatively small area of intake.

Part of the ground water is discharged by seeps and springs along the W. side of Playas Lake. Phreatophytes along the W. side of the lake also remove pond water. Additional water may leave the valley through Hatcher Gap, the gap between the Animas and Pyramid mountains, and the gap between the Coyote Hills and Pyramid Mountains.

The water in Playas Valley is generally suitable chemically for stock and domestic use and for irrigation, although B in the northern lake area may be injurious to crops most sensitive to B. In 12 samples the concentration of fluoride was greater than the recommended maximum in water for domestic use. Most of the samples analyzed are classed as sodium bicarbonate water.

Irrigation wells in Tps. 30, 31, and 32 S., R. 16 E., discharge the greatest amounts of ground water. Many wells in the valley. Water levels in irrigation wells near Hatcher Gap have declined about 2 ft. per year since pumping began in 1948. Water levels in some stock and domestic wells declined 7 to 8 ft. from 1913 to 1956. Apparently, annual pumpage from the main body of ground water in the valley exceeds annual recharge, and, as the natural discharge probably has not decreased, the ground water is at present pumped from storage. Maximum long-term utilization of the supply will require proper spacing of wells and other conservative practices.--Auth.

2122. Perlmutter, Nathaniel M. SOURCES OF GROUND WATER IN SOUTHEASTERN NEW YORK: S. Geol. Survey, Circ. 417, 9 p., fig., 1960.

Igneous, sedimentary, and metamorphic rocks compose the bedrock in the 6 metropolitan counties of New York City. Glacial till and outwash overlie the bedrock almost everywhere. Wells in most of the bedrock and in till supply water sufficient for domestic use, but several aquifers, such as the Newark group [Triassic], the Inwood limestone [Cambrian], and the outwash deposits, yield enough water for public supply and industrial use.--S. Geol. Survey.

2123. Perlmutter, Nathaniel M. GEOLOGY AND GROUND-WATER RESOURCES OF ROCKLAND COUNTY, NEW YORK, WITH SPECIAL EMPHASIS ON THE NEWARK GROUP (TRIASSIC): New York State Water Power & Control Commission, Bull. 42, 133 p., 13 figs. incl. maps, secs., graphs, pls. (in pocket) incl. 3 maps, sec., 18 tables, 59, 27 refs.

This report is part of a cooperative investigation by the U. S. Geological Survey and the New York State Water Power and Control Commission of ground-water conditions in New York. Rockland County, encompassing an area of about 200 sq. mi., is located in the southeastern part of the state. The population in 1957 was about 114,000. The altitude of the land surface ranges from sea level in the eastern part of the county to about 1,300 ft. in the western part. Precipitation averages about 47 in. per year.

The principal bedrock units are: 1) Precambrian crystalline rocks, 2) the Newark group, which is composed of sedimentary rocks of Triassic age, 3) the Palisade diabase of Triassic age, and 4) quartzite, gneiss, and shale of Cambrian and Ordovician age. The Newark group underlies the eastern two-thirds of the county, and the Precambrian rocks underlie the rest of the remaining area. Deposits of Pleistocene

till cover most of the bedrock surface. Stratified drift composed of sand, gravel, silt, and clay overlies the deposits of till in many stream valleys. The stratified drift is generally less than 100 ft. thick, but in the buried channel of the Hudson River it may be as much as 600 ft. thick.

Ground water derived from precipitation within the borders of the county is the chief source of water supply. The principal aquifers are the Newark group and stratified drift. Yields of wells in the Newark group range from 3 g.p.m. (gallons per minute) to about 1,500 g.p.m. The median yield of 25 large-diameter public-supply wells is 300 g.p.m. and the median depth is 407 ft. Wells in other bedrock units generally yield less than 10 g.p.m. and are less than 200 ft. deep. The median yield of 18 wells in stratified drift is 183 g.p.m. and the median depth is 26 ft. Yields of as much as 1,500 g.p.m. have been reported from test wells tapping stratified drift in the Ramapo and Mahwah River valleys where conditions are favorable for induced river infiltration.

Water levels in some wells in the Newark group fluctuate as much as 30 to 40 ft. annually, largely owing to the influence of pumping. Ground-water withdrawals in 1956 averaged about 10 m.g.d. (million gallons daily) and was mostly from the Newark group.

Water in the bedrock, on the average, has moderate hardness, low concentration of Fe, and is slightly alkaline, but in some places the water is very hard and is acidic. Water in stratified drift is generally soft to moderately hard and is acidic. At several places along the shore of the Hudson River both the stratified drift and the Newark group contain salty water derived from the Hudson River. The average temperature of the ground water is about 51° F.

Additional substantial ground-water supplies are available from stratified drift in the Mahwah and Ramapo River valleys and from the Newark group chiefly in the western part of the county.--Auth.

2-2124. Brown, Philip Monroe. GEOLOGY AND GROUND-WATER RESOURCES IN THE GREENVILLE AREA, NORTH CAROLINA: North Carolina, Dept. Conserv. & Devel., Div. Mineral Resources, Bull. no. 73, 87 p., 10 maps, diag., graph, 1959, 35 refs.

The area described in this report includes the following counties: Beaufort, Bertie, Chowan, Gates, Greene, Hertford, Martin, and Pitt. These counties lie in the N.-central Carolina Coastal Plain and extend in a N.-S. direction from the Virginia state line S. to the Neuse River.

The area is underlain by a group of sedimentary formations that thicken in a SE. direction and slope toward the SE. at a rate of 15 to 30 ft. per mi., forming a simple monocline. The stratigraphic relationships are more complex; the oldest sediments, exposed at the surface in the SW. and central sections of the area, are transgressively buried by younger sediments in a NE. direction along the prevailing strike.

The hydrology of the area is controlled by sediments of Mesozoic and Cenozoic age: sands, clays, marls, and limestones of Early Cretaceous, Late Cretaceous, Paleocene, Eocene, Miocene, and Quaternary age. Ground water in the area is largely undeveloped in terms of the ultimate potential supply. Generally speaking, no one section in the area is presently using more than one-fourth or one-fifth of the available and replenishable supply of ground water. There are sections where little of the large potential supply available is being used.

The majority of wells throughout the area are shallow dug or driven wells that yield from several to 20 g.p.m. Drilled municipal and industrial wells may yield from 200 to 1,000 g.p.m., according to their location and depth.

The water obtained from most wells is generally of adequate quality. It ranges from the relatively hard calcium bicarbonate waters emanating from shallow marls and limestones to the soft sodium bicarbonate waters in the deeper "greensands." Saline waters occur progressively nearer the land surface toward the present coastline. Waters having high concentrations of fluoride occur in some areas of Bertie, Gates, Hertford, and Martin counties.--Auth.

2-2125. Norris, Stanley E. BURIED TOPOGRAPHY AND ITS RELATION TO AN IMPORTANT AQUIFER IN FRANKLIN COUNTY, OHIO: Ohio Jour. Sci., v. 59, no. 6, p. 341-343, fig., Nov. 1959.

The relationship between buried topography and the occurrence of a sand and gravel aquifer in Franklin County, Ohio, demonstrates the importance of buried valley studies in water resources investigations in glaciated regions. In eastern Franklin County a buried lowland, developed on beds of soft shale, is a repository for thick and extensive deposits of permeable sand and gravel. The sand and gravel were deposited by glacial meltwaters which were confined to the lowland by abutments formed by more resistant rocks on either side. These permeable deposits compose an aquifer of great potential importance to the Columbus metropolitan area.--Auth.

2-2126. Johnston, Paul M. GROUND-WATER SUPPLIES IN SHALE AND SANDSTONE IN FAIRFAX, LOUDOUN, AND PRINCE WILLIAM COUNTIES, VIRGINIA: U.S. Geol. Survey, Circ. 424, 7 p., fig., 1960.

Water-bearing characteristics of Triassic rocks, as shown by 2 wells drilled at the site of the new Dulles International Airport at Chantilly, Virginia, indicate that these rocks may be of substantial importance as sources of moderately large water supplies for municipal and industrial use, in addition to their traditional role as sources of small domestic and farm water supplies.--U.S. Geol. Survey.

2-2127. Newcomb, Reuben C. STORAGE OF GROUND WATER BEHIND SUBSURFACE DAMS IN THE COLUMBIA RIVER BASALT, WASHINGTON, OREGON, AND IDAHO: U.S. Geol. Survey, Repts., Open-File Ser., 31 p., 10 figs. incl. illus., maps, diags., sec., Apr. 1960, 7 refs.

The Columbia River basalt is a thick sequence of accordantly layered lava flows. It forms the bedrock beneath about 50,000 sq. mi. in Washington, Oregon, and Idaho.

The rubbly rock at the tops and bottoms of some of the flows is permeable and transmits water horizontally along the flow stratifications. Where the strata are interrupted by vertical displacements (faults), barriers to movement of the water are commonly present. Where these barriers are transverse to the dip of the basalt layers, ground-water reservoirs are formed. Many such reservoirs are present in mountainous areas or on the flanks of mountain uplands, and their water has been little used to date.

Properly designed and constructed wells are suggested as a means of testing the feasibility of with-

drawing water from these reservoirs during the summer months and allowing them to refill during the winter and spring. Benefits from such a practice may be especially great in stream valleys where water is needed in the late summer.--Auth.

2-2128. Mundorff, Maurice John. GEOLOGY AND GROUND-WATER RESOURCES OF CLARK COUNTY, WASHINGTON, WITH A DESCRIPTION OF A MAJOR ALLUVIAL AQUIFER ALONG THE COLUMBIA RIVER: U.S. Geol. Survey, Repts., Open-File Ser., 660 p., 36 figs. incl. illus., maps, secs., graphs, 3 pls. (in pocket) incl. 2 maps, diag., 19 tables, Aug. 1959, 37 refs.

The important conclusions are that adequate yield of water suitable for all uses can be obtained from wells in most farmed areas. The total available supply is sufficient for all foreseeable irrigation developments. In a few local areas aquifers are fine grained, and yields of individual wells are low. Surface water resources are very large.

An enormous ground-water supply is available from aquifers underlying the flood plain of the Columbia River, and recharged by it, in the vicinity of Vancouver, Camas, and Washougal. Yields of individual wells are large, ranging up to 4,000 g.p.m.

Eocene to Miocene volcanic lava flows and pyroclastics, including some sedimentary strata, crop out in the foothills of the Cascades in the eastern part of the county and underlie younger, unconsolidated rocks in the lowlands to the W.

Small to moderate quantities of water can be obtained from fractures in the older rocks. However, in the populated areas, these rocks generally are overlain by more permeable materials, and few wells have been drilled in them. Springs and dug wells yield an ample domestic supply at a number of farms in the foothills.

The younger (Pliocene to Recent) unconsolidated materials were deposited, chiefly by streams, in the basin formed by downwarping of the older rocks. However, some lake deposits and glacial drift also are included. The oldest unit of this group, the lower member of the Pliocene Troutdale formation, consists of clay, silt, and fine sand but includes lenses of coarser sand and, rarely, gravel. Its maximum thickness is 660 ft. This unit is generally not a good aquifer, but at a few places lenses of coarser grained materials have yielded small to moderate amounts of water.

The upper member of the Troutdale formation (early Pleistocene?) consists of lightly to moderately cemented gravel having many quartzite pebbles. Its average thickness may originally have been 300 to 400 ft. It crops out over considerable areas in the county and in places has been very deeply weathered. This member is one of the best aquifers, and most irrigation supplies are obtained from it. The best aquifers are the cleaner, uncemented, or only lightly cemented sand and gravel layers below the weathered zone. Yields of several hundred gallons per minute are common, and some wells yield more than 1,000 g.p.m.

Basaltic lava flows (Boring lava) overlie the Troutdale formation at a few places. The flows were extruded from local vents which cut through the Troutdale and the older formations. The Boring lava generally is a moderately good aquifer, yielding water from vesicular, scoriaceous, and cinder zones.

Glacial drift blankets much of the area N. and NE. of Battle Ground. Glaciofluvial-outwash deposits underlying Chelatchie Prairie and Yacolt Basin are

meable and probably are good aquifers, but they are largely untested. A great deltaic fan of the Columbia River was deposited downstream from the mouth of the gorge near Washougal. It lies directly on the upper member of the Troutdale formation, but in a few places lies on other rocks. The Columbia River has cut down through the deltaic fan and large-scale terraces, leaving a series of benches and terraces. The coarser phases of these deposits are extremely permeable and yield large quantities of water. The broad benches are underlain by the coarser, more permeable strata above the zone of saturation. The largest supplies are obtained along the valley of the Columbia River at Washougal, Camas, and Vancouver. Yields are commonly more than 1,000 g.p.m. in drawdowns of only a few feet. Several wells have yielded more than 4,000 g.p.m. The foothills area is underlain chiefly by consolidated volcanics which will yield only small to moderate supplies of water from joints and other fractures. These rocks generally are deeply weathered, and the residuum yields small supplies to dug wells. In the larger intermontane valleys, water is obtained from fluvial and glaciofluvial sand and gravel. Although moderate to large supplies probably are available at several places, generally only small supplies have been developed. In the alluvial plains and benches wells obtain water from sand and gravel at depths less than 300 ft. The Troutdale bench, the highest, is underlain by the Troutdale formation, which has been weathered to depths of 100 ft. or more. At some places, where weathering has reached or nearly reached the base of the upper member of the Troutdale, little or no water has been obtained. At other places, where weathering has been less deep, moderate supplies are obtained from the upper member of the Troutdale. A few wells obtain small to moderate yields from the underlying lava, and some obtain scanty to moderately good supplies from volcanics beneath the Troutdale. The Fourth Plains area lies between 150 and 300 ft. and includes most of the irrigation wells. There are 2 important aquifers in the area: 1) the Pleistocene alluvial deposits, and 2) the upper member of the Troutdale formation. The Pleistocene alluvial deposits form a blanket from a few feet to about 200 ft. thick. However, where they are thickest and most permeable, the ground water drains out readily, and the water table generally is far below the surface, so that these deposits are dry or saturated only near the base. Where the deposits are thin or are finer grained, perched or semiperched ground water is obtained from lenses of coarser grained materials. The upper member of the Troutdale formation furnishes several hundred gallons per minute to 1,000 g.p.m. almost everywhere in the Fourth Plains area. Total annual recharge to the principal aquifers in the upper member of the Troutdale formation in

the Fourth Plains area is on the order of 150,000 acre-ft. A large part of this ground water could be recovered if needed.

The lowland and flood-plain areas along the Columbia, Lewis, and the East Fork of the Lewis River are underlain by alluvial deposits ranging from a few feet to more than 100 ft. in thickness. The coarser grained strata are extremely permeable and yield very large amounts of water. W. of Vancouver, coarse sand and gravel in the Troutdale formation underlie the alluvial deposits and also yield large amounts. Many wells in the vicinities of Camas and Vancouver yield more than 1,000 g.p.m., and several were tested at 4,000 g.p.m. or more. Specific capacities commonly are several hundred, and a few exceed 1,000. Recharge is derived from underflow from upland areas to the N. and E. and also from the Columbia River.

Domestic and stock use of ground water is estimated to be 3.6 m.g.d. Public-supply systems use about 9 m.g.d. of water, of which more than 7 m.g.d. is ground water. Much of the water used by industry is obtained from wells. Total industrial use of ground water is about 75 m.g.d. Records show that 137 farms irrigated more than 3,000 acres from wells in 1955. This report lists 172 irrigation wells, which annually pump an estimated 8,000 to 10,000 acre-ft. --From auth. abs.

2-2129. Walters, Kenneth L. AVAILABILITY OF GROUND WATER AT THE BORDER STATIONS AT LAURIER AND FERRY, WASHINGTON: U.S. Geol. Survey, Circ. 422, 8 p., 3 maps, diag., 2 tables, 1960.

In the Laurier area, the Kettle River has cut into crystalline rocks in the deepest part of the valley. Sand and gravel fill were deposited in the valley during Pleistocene time by melt water from glaciers, and subsequent erosion and alluviation formed 3 terrace levels. The highest level, on which Laurier border station is situated, is about 200 ft. above present river level. The intermediate terrace is 150 to 180 ft. above river level. Wells on the intermediate terrace yield about 4 g.p.m. (gallons per minute) per ft. of drawdown. Larger yields probably could be obtained from wells on the lowest terrace (flood plain).

In the Ferry area, the valley fill of the Kettle River valley is as much as 150 ft. thick and contains boulders that are as much as 18 in. in diameter. Small to moderate quantities of water probably would be available from wells on the high-terrace level. Large quantities of water are obtained from irrigation wells on the low terrace.

The bedrock at both sites is relatively impermeable and probably would yield very meager supplies of water. --Auth.

12. MINERAL DEPOSITS

Also: Geologic Maps 2-1938, 2-1939, 2-1948; Geology 2-2033, 2-2080; Mineralogy 2-2101; Fuels 2-2160.

130. Schanz, John J., Jr. ELEMENTS OF MINERAL ECONOMICS: 108 p., 10 figs. incl. secs., 10 tabs., graphs, 8 tables, University Park, Pennsylvania State University, College of Mineral Industries, 1959, 9 refs.

An introductory text, at the college level, in mineral economics, a specialized field of applied economics wherein the more exact fields of engineering and science meet with the inexact fields of business and economics. Its objective is to impart an understanding of the nature of mineral resources and the industries which produce them. This involves not only the economic behavior of the mineral industries but also the role of technologic progress in their development.

Topics covered include: outline of physical geology, minerals in history, principles of mineral economics, mineral industries finance, world distribution and trade in minerals, mineral position of the United States, mineral policy, and mineral conservation.--M. Russell.

2-2131. Bachmann, H.G. THE ORIGIN OF ORES: *Sci. American*, v. 202, no. 6, p. 146-150, 152, 154, 156. 2 illus., diags., June 1960.

Only local concentration of the metals in the crust enable man to find and use them. Geochemists have recognized several stages in the concentration of ore bodies. Segregation of the Ni-Fe core of the earth was the first step, followed by crystallization and settling of heavier ores in the molten mantle. Cr deposits were formed this way. As magma hardens, some disseminated particles of segregating ores may be caught up in an "injection" as in the famous Sudbury Ni-Cu deposits and the Kiruna magnetite lode. As temperatures decrease, pegmatites form with well-crystallized ores of U, W, Mo, and Ta, among others. In a later stage, hot ascending gases and magmatic solutions bring up a wide variety of metals and deposit them in cooler rocks as veins. Most workable ores fall in this category. As weathering occurs, some metals and oxides are concentrated and deposited as placers in stream beds, etc. The dissolved ions may precipitate in standing water and give rise to sedimentary Fe or other important metals. Lastly, some ores, notably bog-Fe ore and some V deposits are concentrated by biological agents, especially bacteria.--R.F. McAllister.

2-2132. Killin, A.F. SURVEY OF THE COPPER INDUSTRY IN CANADA, 1958: Canada, Mineral Resources Div., Mineral Inf. Bull., MR 37, 108 p., map, 2 graphs, 14 tables, Oct. 1959.

A detailed review on the sources of primary production, trade, and consumption of Cu. A list of Cu producers in 1958 is followed by a province-by-province survey of exploration and operations of these producers. Production of all forms of Cu in Canada in 1958 amounted to 345,114 short tons, a reduction of 13,995 tons from 1957. Several producing mines closed in 1958. The decrease in Ontario's production is attributable to production cutbacks and the strike at International Nickel Company plants. The increase in Quebec production was the result of increased production of Gaspé Copper Mines Ltd. and mines in the Chibougamau area. Decreased production in New Brunswick shows the effect of closure of mines in the Newcastle-Bathurst area. A sharp increase in Newfoundland is accounted for by a steady rate of production at the Tilt Cove mine of Maritimes Mining Corporation Ltd. The closure of the Britannia Mining & Smelting Co. Ltd. mine at Britannia Beach was the major factor contributing to the decrease in production in British Columbia.--From auth. summ.

2-2133. Itsikson, M.I. THE DISTRIBUTION OF TIN-ORE DEPOSITS WITHIN FOLDED ZONES: Translated by William A. Kneller: *Internat. Geology Rev.*, v. 2, no. 5, p. 397-417, graph, 2 tables, May 1960, 37 refs.

The author makes an attempt to establish the general laws governing distribution in time and position of Sn-bearing centers and areas in the course of the geological history of the earth on the basis of

methods of regional metallogenic analysis developed in the U.S.S.R. by a group of scientists under the guidance of G. A. Bilibin. The author has considered the principal geotectonic and structural geological features and factors controlling the regular occurrence, during a certain stage of development of a folded zone, of a certain type of Sn-bearing intrusions and, hence, of a certain mineralogical-geochemical type of Sn deposit.

Considerable Sn concentration evidently did not take place during the initial and early stages in development of folded zones. The middle stages of development, corresponding to the period of transformation of a geosyncline into a folded belt, were highly productive with regard to Sn. Sn accumulations are associated with syntectonic batholithic intrusions of acid and ultra-acid "K" granites. Sn-bearing batholiths and their linear belts are controlled by regional ancient deep-seated fractures, confined either to the points of anticlinorium contact (central upheavals) with the adjacent inner synclinoria or to the contact points of downwarps with consolidated geanticlinal zones. The late stages of development of geosynclinal regions corresponding to the period of consolidation of the folded territory also produced considerable Sn concentrations.

According to the depth of the controlling intrusions the showings of Sn occurrences belonging to the late stages of development are subdivided into 2 natural groups: the hypabyssal and the subvolcanic. Sn ore-bearing areas belonging to the late stages of development are confined to the following 2 types of geotectonic environments: 1) the mobilized marginal parts of geosynclines in places of their contact with projections of platforms of intermediate massifs (blocks) and consolidated geanticlinal structures. A number of large Sn ore-bearing areas is confined to structures of late superimposed grabenlike downwarps (complicated by fractures) with a powerful development of terrestrial volcanism; 2) the inner portions of geosynclines, where the Sn ore-bearing areas are confined to structural facial zones of inner synclinoria, more frequently in places of contact of the latter with zones of central uplifts.

The distribution of world Sn resources in the course of geological times is as follows: Pre-cambrian, 3.3% (Nigeria, Rhodesia, Congo, Union of South Africa); Caledonian folding, 6.6% (Africa and Australia); Variscan folding, 18.1% (Cornwall, Erzgebirge, the Pyrenees, Australia, Tasmania); Kimmeridgian folding, 63.1% (Southeastern Asia).

Simultaneously with the growth of commercial Sn concentrations from the Precambrian to the Mesozoic, complication of the nature of Sn mineralization is observed from Sn-bearing pegmatites in the Precambrian to complex multicomponent deposits in the Mesozoic and the Cenozoic.--Auth.

2-2134. Miller, Elbert E. OUTLOOK FOR URANIUM: *Focus*, v. 10, no. 7, 6 p., 4 maps, March 1960, 6 refs.

A review article on the present status of U as fuel for peacetime uses. Aspects covered include physical characteristics of U, location and amount of known reserves in the world, costs of production, radioactive waste disposal, factors encouraging development, and agencies of the world currently engaged in development or plans for development.--M. Russell.

2-2135. Griffith, J.W. A SURVEY OF THE URANIUM INDUSTRY IN CANADA: Canada, Mineral Re-

sources Div., Mineral Inf. Bull., MR 34, 94 p., maps, 2 diags., graph, 4 tables, Nov. 1959, refs.

In recent years, the Canadian U industry has grown from a minor component in Canada's mineral economy to a position of first importance. In 1958 the value of U production was greater than that of any other mineral commodity except petroleum. Canada has also achieved international prominence in U and in 1958 was the world's leading producer.

This report is a summary of information on the Canadian U industry up to the end of 1958 but includes some developments up to the end of Nov. 1959, including the "stretch-out" plan for delivery of U to the end of 1966. Although much has been written about the industry in various publications, this bulletin attempts to bring into 1 volume a description of all Canadian producers and former producers. Other important U deposits have not been included because these will be described in the forthcoming second edition to Canadian Deposits of Uranium and Thorium, Geological Survey of Canada, Economic Geology Series No. 16.

The report also deals with Canadian U production in 1957 and 1958, ore reserves, world production and reserves, mining and milling methods, costs, refining, uses, prices, markets, and a brief outline of Th in Canada.--From auth. pref.

2-2136. Rose, E.R. RARE EARTHS OF THE GRENVILLE SUB-PROVINCE, ONTARIO AND QUEBEC: Canada, Geol. Survey, Paper 59-10, 41 p., 7 tables, 1960, 30 refs.

Sixty-five reported occurrences of rare-earth minerals were examined during summer 1957. Particular attention was paid to occurrences carrying the "heavy" rare earths. Most of the occurrences are in more or less zoned granitic pegmatite dikes, and a few are in pegmatitic granite and granitic gneiss. Many are of relatively rare minerals found during the course of feldspar mining and are of a purely mineralogical interest. Few of the deposits hold promise of economic recovery of rare-earth elements except as by-product materials, but the fact that several of the occurrences do hold small quantities of the heavy rare earths, and of U, Th, and Nb, lends some incentive to their investigation for possible future application.

The U deposits of the Blind River and Bancroft areas of Ontario, and the Nb deposits of the Oka and Lake Nipissing areas of Quebec and Ontario respectively appear to be the most promising known sources of the rare earths in Canada. Minerals rich in the heavy rare earths are contained in some pegmatite dikes of the Grenville subprovince and elsewhere in the granitic terrains of Canada, but their distribution within the dikes is normally sparse and sporadic. These and other possible sources of rare-earth metals might be investigated if the demand warrants it.

Although rare-earth elements are not significantly radioactive, they are commonly associated with U and Th. Therefore many of the minerals containing rare earths may be detected by delicate Geiger counters or scintillometers.

The rare earths have relatively large ionic radii and become enriched in late residual fractions of igneous rocks. Thus they are concentrated in pegmatites, granites, syenite and alkaline intrusions, and in hydrothermal or contact deposits associated with such intrusions. The rare-earth content of many igneous rocks is, however, exceeded by that of certain deposits of black shale, coal, petroleum, limestone, dolomite, and phosphorite. For this reason

it would appear that metamorphic rocks developed at the contacts of such materials and igneous rocks, particularly alkaline intrusions, might be locally enriched in rare-earth minerals.--From auth summ.

2-2137. Janes, T.H., and R.B. Elver. SURVEY OF THE CANADIAN IRON ORE INDUSTRY DURING 1958: Canada, Mineral Resources Div., Mineral Inf. Bull., MR 31, 148 p., 5 maps, 2 graphs, June 1959, refs.

A detailed study of the production, trade, and developments of the industry. General information on world production, Canadian iron and steel industry, world trade, production and market forecasts, ore prices, tariffs, and iron ore classification, minor constituents, and beneficiation makes up the first part of the report. The second part deals with exploration and operations by the companies producing iron ore in 1958 in Canada, by provinces.--A.C. Sangree.

2-2138. Waddington, G.W., comp. IRON ORE DEPOSITS OF THE PROVINCE OF QUEBEC: Quebec, Dept. Mines, Prelim. Rept. no. 409, 89 p., fold. map, 1960, refs.

This compilation briefly describes all known occurrences of Fe ore in Quebec, alphabetically by township, giving a summary of exploration, development, and exploitation work done. Titaniferous Fe ore and Fe-bearing sands are included; deposits of bog Fe ore are not included. All known sources of information are listed in the references accompanying each description. Reports containing lists of occurrences or casual mention with no description are not included in the references except in those cases where no description of the deposits is available. Names of companies are given in some cases as a means of identifying the locality. They have at one time held the property or performed exploration work on it, but are not necessarily the present owners. This report supersedes Prelim. Repts. no. 173 and no. 262.--A.C. Sangree.

2-2139. Lloyd, Trevor. MINING DEVELOPMENT ON UNGAVA BAY: Cahiers de Géographie de Québec, v. 3, no. 6, p. 321-328, 2 illus., map, table, Apr.-Sept. 1959, 6 refs.

Logistic problems commanding an economic exploitation of the Fe ores of Ungava Bay, northern Quebec, are briefly dealt with. The main problem is the shipping of large quantities of ores from a remote area, which is open for shipping only during 4 to 4 1/2 months each year. It has been proposed therefore to provide a transfer station in ice-free waters. A survey has been made of the ice conditions and of other geographical features, and a site for a transfer station has been selected provisionally on an island near Godthaab on the SW. coast of Greenland. A similar arrangement for transport might be used for Baffin Island mines.--C. Volte.

2-2140. Hansen, Miller. CLAYS OF NORTH DAKOTA AS A POTENTIAL SOURCE OF ALUMINA: North Dakota Geol. Survey, Rept. Inv. no. 33, 14 p., 2 illus., 1959, 10 refs.

Clays in several localities in North Dakota are known to contain in excess of 20% alumina. This investigation was an attempt to locate clay deposits of 20% or higher alumina content of sufficient size to

supply an Al plant for at least 25 years. Samples collected were analyzed for alumina by the method of basic fusion of the clay followed by a pH titration. A plant to manufacture alumina from the clay by the lime-soda-sinter process would require a minimum deposit of 50 million tons of clay containing 20% or more Al_2O_3 in addition to an adequate supply of water, lignite, and limestone. No deposits meeting the requirements were found.--Auth.

2-2141. Grenier, Fernand. L'INDUSTRIE CANADIENNE DE L'AMIANTE [THE ASBESTOS INDUSTRY OF CANADA]: Cahiers de Géographie de Québec, v. 3, no. 6, p. 329-341, 2 maps, graph, table, Apr.-Sept. 1959, 25 refs.; text in French.

The history and production of the main asbestos mines and mining towns of Canada since their start are briefly treated, and the use made of the mineral is mentioned. Until 1950, production was centered almost exclusively in the Thetford-East Broughton area, in the Appalachians of SE. Quebec, where asbestos occurs in the serpentine belt extending from the Gaspé Peninsula to the NE, as far as Vermont in the SW. Mining started in 1877. Recently mining operations were begun in several other sections of Canada. The world production of asbestos in 1956 was 1,750,000 short tons, of which 1,055,541 tons had a value of over 100 million dollars. The mineral is almost entirely exported, a large part of it to the United States. Industry using this raw material is not yet very much developed in Canada.--C. Voûte.

2-2142. Williamson, D. R., and Lorraine Burgin. PUMICE AND PUMICITE: Colorado School Mines, Mineral Industries Bull., v. 3, no. 3, p. 1-12, map, graph, 6 tables, May 1960, 41 refs.

Pumice and pumicite are volcanic glass pyroclasts having extremely fine cellular structure. Physical appearance and structure should be the basis of division of pumiceous glasses. The cellular structure of pumice is formed by retention of a part of the gas formed during eruption. Glasses which contain pores and curvature, whether fine or coarse, could be called pumice. Accumulations of flakes of platy, solid glass could be called pumicite. The uses of pumice and pumicite are primarily as construction materials, secondarily for construction of roads and railroads, and thirdly for the manufacture of abrasives. Domestic production is about 2 million short tons per year, valued at about \$5.3 million. The major part of United States production comes from a few operations in 5 western states. Although some pumice products are profitably shipped throughout the world, the bulk of production must be marketed within a very few hundred miles of the mine.--M. Russell.

2-2143. White, W. Arthur. LIGHTWEIGHT AGGREGATE FROM ILLINOIS SHALES: Illinois State Geol. Survey, Circ. 290, 29 p., illus., map, diag., 2 tables, 1960, 11 refs.

This investigation was made 1) to determine which shales are self-bloating and which require the addition of bloating agents and 2) to study the mechanism of bloating. Samples of shale ranging in age from Ordovician to Pleistocene were collected from brick and lightweight aggregate pits, strip coal mines, outcrops, and drill cores.

The samples were crushed, screened, and analyzed

chemically and mineralogically. The coarse material was put in a crucible and heated in a furnace at 2,200°F. (1,200°C.) for 1 hour, and the apparent specific gravity was determined.

The optimum organic C content for self-bloating shales was found to be between 0.3 and 1.0%. Too much C kept the shale from bloating and too little prevented the desired bulk density from developing. Most of the nonbloating shales bloated after the addition of 1% of fine coal.

Too much kaolinite and/or quartz make the material too refractory for economic production of aggregate. Too much dolomite and/or calcite cause too narrow a firing range.

Self-bloating shales probably could be made into lightweight aggregate in both rotary and grate-type kilns. Shales that need bloating agents added could be processed in a grate-type kiln in which the fuel is mixed with the shale.--Auth.

2-2144. Dubnie, Amil. SOME ECONOMIC FACTORS AFFECTING NORTHERN MINERAL DEVELOPMENT IN CANADA: Canada, Mineral Resources Div., Mineral Inf. Bull, MR 38, 61 p., fold. map, Dec. 1959, 104 refs.

The future growth of Canada as a major world producer of minerals will depend on the continued expansion of mining activity into remote areas. The extent of such expansion will be determined in large part by the success in dealing with economic problems of northern Canada.

The first part of this paper provides a description of prevailing northern conditions, with particular emphasis on those conditions which affect mining operations. The second part of the paper presents some detail on northern mining experience. An order of magnitude is established for some of the additional costs which have to be met in mining operations in northern Canada. In presenting an appraisal of mining costs, an attempt is made to give some perspective to the problems of mineral resource development in the N.--From auth. pref.

2-2145. Alaska, Division of Mines and Minerals. REPORT... FOR THE YEAR 1959: 80 p., map, 2 graphs, 6 tables, [Juneau, 1960].

The Division of Mines and Minerals conducts a continuing survey of the mineral resources and operations of Alaska and disseminates it for the benefit of all concerned with the minerals industry. It maintains an oil and gas section, operates assay offices, and conducts field investigations and safety inspections. Alaska's total mineral production in 1959 decreased in value 9% from 1958. Au and coal production have dropped for 2 straight years although they remain the top 2 commodities. Sand and gravel is third, and production increased in 1959; stone production decreased. Production of Hg and Pt increased moderately, and oil was produced in significant amounts for the first time since 1933. Lists of active mining operations, active coal mines, and active oil and gas companies are included.--M. Russell.

2-2146. Sorensen, Harry O., and Emery T. Carlson. MICHIGAN MINERAL INDUSTRIES, 1958: 93 p., maps, tables, Lansing, Michigan, Geological Survey Division, Nov. 1959.

A record of mineral industries for the calendar

year 1958. Production statistics cover Fe ore, Cu, petroleum, natural gas, Portland cement, salt, natural salines, sand and gravel, stone, clay and shale, gypsum, peat, lime, marl, and gem stones. A directory of producers is included.--M. Russell.

2-2147. Nackowski, M. P., and Enrique Levy. MINERAL RESOURCES OF THE DELTA-MILFORD AREA: Utah, Univ., Eng. Expt. Sta., Bull. no. 101 (Utah, Univ., Bull., v. 50, no. 18), 112 p., 17 maps, 12 tables, Sept. 1959, 78 refs.

The mineral industries of the Delta-Milford area, 9,221 sq. mi. of SE. Utah, are surveyed. The mineral resources are catalogued, recent mineral production summarized, and future mineral economic potential evaluated. Economic and geologic data are given for the following principal mineral commodities: Cu, Au, Pb, Ag, Zn, Fe, Mn, Wo, S, fluorspar, limestone, dolomite, cement, sand, gravel, volcanic commodities, perlite, pozzolan, pumice and pumicite. Brief descriptions and notes on distribution are given for the following minor mineral commodities: U,

asbestos, barite, clay, cinnabar, diatomite, gem stones, gypsum, and stone.--M. Russell.

2-2148. U. S. Geological Survey. MINERAL AND WATER RESOURCES OF WYOMING. REPORT... PREPARED AT THE REQUEST OF SENATOR GALE W. MCGEE OF WYOMING: U. S. 86th Cong., 2d sess., 1960, Senate, Document, no. 76, 40 p., 9 maps, 8 tables, 1960, refs.

This report summarizes the mineral and water resources of Wyoming by showing their general distribution, indicating their status and value, and suggesting possibilities for their development and utilization. Included as resources are the metals and non-metallic minerals, the mineral fuels, construction materials, surface and ground water, and water power. Selected references are given after each item in the report. Large-scale resource maps show the following: principal U districts and U processing mills, Fe deposits, trona, gypsum, oil and gas fields, coal-bearing areas, oil shale, average annual runoff, and ground-water aquifers.--M. Russell.

13. FUELS

See also: Geologic Maps 2-1940, 2-1941, 2-1945 through 2-1948; Stratigraphy 2-1998; Geophysics 2-2033, 2-2082; Mineral Deposits 2-2145.

2-2149. Brechtel, Fred C., and Don B. Gould. ARCTIC ISLANDS ALLOW FAST PHOTOGEOLOGIC EVALUATION: World Oil, v. 151, no. 1, p. 103-107, 2 ports., 4 illus., 3 maps, July 1960, 4 refs.

A brief summary of the value of photogeology in the Canadian Arctic Islands, including general geologic aspects of these islands. Due to a short field season and high transportation costs photogeology is proving valuable in the Arctic Islands and can be used extensively as forest cover is absent, snowfall is light, and glacial deposits are restricted. The occurrence of large sedimentary basins and the presence of bituminous materials has been verified. Conditions in the NW. part of arctic Canada are favorable for the occurrence of petroleum where a maximum thickness of Paleozoic and younger rocks is as great as 80,000 ft. combined with a variety of structural conditions. Main orogenic events have occurred in late Silurian, post-Devonian and pre-middle Pennsylvanian. The Arctic archipelago is divided into 4 tectonic and sedimentary regions: the Shield, Arctic lowlands and plateaus, Inuitian region, and Arctic coastal plain. The favorable regions contain thick sediments, piercement domes of anhydrite and gypsum, numerous folds, and many stratigraphic variations. A program is now in progress to supply complete vertical photo coverage to speed up the mapping and furnish a framework for ground observations.--E. R. McAuslan.

2-2150. Kornfeld, Joseph A. HOW TO CHOOSE EASTERN OKLAHOMA DATUM PLANES: World Oil, v. 151, no. 1, p. 124, 126-127, 130-131, port., map, 3 log secs., July 1960.

This paper discusses briefly the selection of key marker beds in the lower Pennsylvanian of eastern Oklahoma. A marker bed should be regional, geologically reliable, easily detected from samples and from electrical and radioactivity logs, and it should be present not far above the objective reservoir. The

principal datum planes are the Lenapah limestone, the base of the Oswego limestone, the Verdigris limestone, the "Pink" limestone, the Inola limestone, and the Brown limestone. These beds, when cross sectioned, aid materially in the locating of stratigraphic traps.--E. R. McAuslan.

2-2151. Rose, Walter D. FLUID FLOW IN PETROLEUM RESERVOIRS. III.-EFFECT OF FLUID-FLUID INTERFACIAL BOUNDARY CONDITION: Illinois State Geol. Survey, Circ. 291, 18 p., 2 diag., 7 graphs, 1960, 11 refs.

Relative permeabilities greater than unity are predicted (for a reason different from that developed in Pt. I of this series), and it is shown that Darcy's Law does not accurately describe mixture flow phenomena in view of the nonzero velocity boundary condition that sometimes exists at the fluid-fluid interfacial boundaries. These indications are not to be gathered from examining available experimental data on relative permeability, but explanations are given to reconcile the discrepancy.

The analyses are based on mathematical models of reservoir rock porous media system. To the extent that the models and the reservoir prototype correspond, we can expect valid inferences that are important to an understanding of the mechanics of oil recovery processes. It is suggested that a flowing fluid has an increased mobility when surrounded (in part or entirely) by another immiscible fluid, whether the phenomenon is one of mixture flow in porous media or the transport of oil in a pipeline containing some annularly located water. The reported lubrication, moreover, is enhanced if the viscosity ratio of surrounding fluid to the flowing fluid has a low value.--Auth.

2-2152. Brod, I. O. MIGRATION AND ACCUMULATION OF OIL AND GAS ACCORDING TO THE SOURCE-ROCK THEORY. Translated by the author: Internat. Geology Rev., v. 2, no. 4, p. 330-345, 2 tables, Apr. 1960, 119 refs.

Practically all oil and gas accumulations through-

out the world are associated with some extensive productive series which consist of highly permeable rocks containing oil and gas pools interbedded with shales and marls containing dispersed organic matter. All of the important recent discoveries between the Volga and the Urals were based on the observed association of oil and gas pools with certain lithologic-stratigraphic complexes of the Devonian, Carboniferous, and part of the Permian, although accumulation is related to many diverse structural zones. Here the productive series is the source rock as well, for the pelites contain dispersed organic matter including bitumen whose composition is related to the oils.

Where accumulations occur in sediments deposited under oxidizing conditions, factors are sought which favor migration from possible source rocks along faults, unconformities, or surfaces of facies change. For example, in Azerbaijan and Turkmenistan large oil and gas accumulations in Pliocene continental beds occur along structural zones that allowed migration from underlying, principally Paleogene and Miocene, deposits.

As shales compact their organic constituents gradually change; the copoly part changes from a ligniferous to a carboniferous stage and ultimately to graphite. The mobile bituminous substances formed by dissociation of organic matter and disproportioning of H₂ change from asphaltenes and resins to oils and then to methane in the subcapillary pores of pelites, where they are in a dispersed, loosely bound state. Compaction causes slow removal of the loosely bound water and molecular migration with differentiation of the bituminous substances. After differentiation, the more mobile hydrocarbons are carried by the water into reservoir rocks. The bituminous substances move from small to large pores also by capillary forces. Migration in subcapillary pores apparently ceases when rocks become lithified and are no longer plastic.

In the super-capillary pores and fissures of reservoir rock, free migration takes place as both molecular migration and movement in larger masses. Water circulates in reservoir beds from elevated areas of the outcrop toward lower discharge areas. When the hydrocarbon-bearing water moves into different environments of temperature and pressure, the hydrocarbons may come out of solution, rise to the top of the carrier-beds, and unite into oil and gas pools if traps are available. The location of oil and gas reflects the present equilibrium of fluids with the structural pattern and hydrogeological environment. --D.C. Van Siclen.

2-2153. Meents, Wayne F. GLACIAL-DRIFT GAS IN ILLINOIS: Illinois State Geol. Survey, Circ. 292, 58 p., 21 maps, sec., diag., graph, 2 tables, 1960, 2 refs.

Glacial-drift gas in Illinois occurs mainly in the NE. fourth of the state in some 60 areas in 27 counties. There are about 460 producing gas wells of which 250 are flowing pressure wells and the remainder are vacuum pumped. Some 172 pressure wells have been tested for open-flow gas volume, and several dozen vacuum-pumped wells have been tested for formation vacuum. More than 200 such gas wells had been abandoned before the testing series began in 1946; many of them were drilled before 1900.

Samples of gas have been collected from 216 wells throughout the state for gas gravity measurements or complete Orsat absorption analyses. Methane content of the gases tested ranged from 22.5 to 95.5%. Gas volume tested ranged from a few hundred up to

1,700,000 cu. ft. per day, average being 70,000 cu. ft. per day.

Formation vacuums range from zero to 14.5 in. mercury, and many of the vacuum-pumped wells flow gas under pressure on days of low atmospheric pressure. Average depth of the glacial-drift gas wells is 132 ft. below the surface. Pressures range from near zero to 64 p.s.i. with the majority of the wells between 5 and 20 p.s.i.

The gas is believed to be derived from buried soil zones and from organic matter in deep buried valleys. The glacial end moraines control the accumulation of drift gas by providing a cover of glacial till thick enough to prevent escape of the gas.

It is estimated that several billion cubic feet of drift gas has been consumed by homes in Illinois since 1900, definitely placing drift gas in the economic group of natural resources.--Auth.

2-2154. Simpson, R. A., and Robert L. Borden A SURVEY OF THE PETROLEUM INDUSTRY IN CANADA, 1957 AND 1958: Canada, Mineral Resources Div., Mineral Inf. Bull., MR 35, 84 p., 2 maps, 5 graphs, 33 tables, June 1959.

This survey covers the main developments in 1957 and 1958 and presents an interrelated review of progress in each of the 4 principal sectors of the industry: exploration, development and production (by provinces); transportation and storage; petroleum processing; and marketing. Historical data are introduced where necessary to set 1957-1958 developments in proper perspective. In certain instances, project plans covering the next few years are mentioned to give an indication of expected trends for the near future.

Activity in the production sector of the industry which had commenced to decline in the latter part of 1957 began to show signs of recovery by the end of 1958, although production of crude oil in Canada in 1958 was below that of both of the years 1956 and 1957. In general, 1958 was the first year in more than a decade in which the petroleum industry had not experienced a continuing expansion in production and marketing operations. After being a 'pace-setter' in Canada's postwar development, the industry in 1958 was actually lagging behind the general, though moderate, advance in economic activity which commenced during the second half of 1958. The main cause of the industry's difficulty lay in the loss of a considerable part of its export market. (Exports of crude oil were at a peak in 1957 of 35.7 million barrels but declined to 31.7 million barrels in 1958.)

At the end of 1958 there were 13,168 oil wells in western Canada capable of production. During the preceding 2 years almost 6,500 wells were drilled, of which some 4,400 were development wells. Several important discoveries were made, but possibly the most significant since the discovery of the Leduc, Redwater, and Pembina oil fields was the Swan Hills oilfield.

Refinery capacity continued to increase and at the end of 1958 reached a total of 827,407 barrels daily in 42 refineries. Product surpluses were evident, and product prices declined through 1958.

Production of crude oil declined to 165.5 million barrels in 1958, after having reached a peak of 181.8 million barrels in 1957. Alberta's production in 1958 dropped by 24 million barrels to 113 million barrels, while production in Saskatchewan increased by 8 million barrels to almost 45 million barrels during the same period. Production in Manitoba and New Brunswick dropped slightly, while in the re-

ing provinces small increases occurred.--From pref. & summ.

55. **BUCKET BRIGADE FOR BUTANE:** Shell, v. 28, no. 6, p. 24-26, 6 illus., June 1960.

The Shell Oil Company is preparing an underground cavern for liquid butane at its Wood River refinery, Roxana, Illinois. Tunneling is by blasting dense limestone at a depth of 432 ft. below surface. When completed, the cavern will have a capacity of 1000 barrels of butane to be stored under sufficient pressure to maintain it in liquid form.--M. Russell.

56. Folsom, Clarence B., Jr., Clarence G. Folsom, and Sidney B. Anderson. **PRELIMINARY REPORT ON THE ANTELOPE-MADISON AND ANTELOPE-SANISH POOLS:** North Dakota Geol. Surv. Rept. Inv. no. 32, 38 p., 22 illus., March 1959, 17 refs.

The Antelope Sanish and Antelope Madison pools are located in McKenzie County in western North Dakota on a small anticlinal fold on the E. flank of the Wesson anticline.

There were 23 producing wells in the Sanish pool as of March 1, 1959. Cumulative production from the Sanish pool as of Jan. 1, 1959, was 1,065,334 barrels of oil. This pool produces from sandstone, siltstone, and shale at the top of the Qu'Appelle formation of Ordovician age. The critical factors in the accumulation of the oil in the Sanish pool are the anticlinal structure and the presence of the sandstone at the top of the Qu'Appelle formation in this area.

The Qu'Appelle formation is overlain by the Madison group of Mississippian age. The Madison group is composed of 4 formations which are in ascending order: Bakken formation, Lodgepole formation, Mission Canyon formation, and Charles formation.

The Madison pool had 41 producing wells at the time of publication. Cumulative production from the Madison pool as of Jan. 1, 1959, was 1,233,803 barrels of oil. This pool produces from several intervals of fractured, fragmental, and oolitic limestones in the lower Charles and upper Mission Canyon formations. The oil accumulation in the Madison pool is structurally controlled, with the productive area roughly paralleling the -6,700 ft. contour line on the "Nesson Marker" structure map.

The Antelope Sanish pool was opened on Dec. 6, 1958. The pool was developed on 160 acre spacing, with only 4 wells completed prior to the discovery of the Antelope Madison pool on May 12, 1956. The Antelope Madison pool has been developed on 80 acre spacing. Ten wells have been completed as completions where the Madison pool overlies the Sanish pool. Both pools are producing under a solution mechanism based on well performance and production history.--Auth.

57. Shearrow, George G., and Theodore A. Folsom. **1959 OIL AND GAS DEVELOPMENTS IN OHIO:** Ohio, Div. Geol. Survey, Rept. Inv. no. 39, 10 charts, 1960.

A total of 1,158 wells were drilled in Ohio in 1959 for oil and gas, and 843 of these became producing wells. The total footage drilled was 1,373,373 for an average of 2,457 ft. per well. The actual production of oil for the year was 1,280 barrels, down approximately 500,000 barrels from the 1958 production. Gas production in-

creased approximately 2 1/2 billion cu. ft. to make a total of 36,311,000,000 cu. ft. of gas produced.

The most significant wells of the year were the 13 tests drilled to the Lower Ordovician and Cambrian. Two of these, a gas well in Medina County and an oil well in Morrow County, produced from the Trempealeau formation of Cambrian age. The most active drilling area was Wayne County where 127 wells were drilled to the Clinton.

The report includes a tabular summary of oil and gas well drilling and production by county and by producing zone.--P. Smyth.

2-2158. Nance, Richard Leon. **CADDO OIL FIELD, CARTER COUNTY, OKLAHOMA:** Shale Shaker, v. 10, no. 7, p. 2-6, 8-13, 3 maps, 5 secs., table, March 1960, 30 refs.

The Caddo oil field is located in the N.-central part of Carter County, Oklahoma, in sections 15, 21-27, 35-36 T. 3 S., R. 1 E. The discovery well of the Caddo oil field, the Pure No. 1 Noble SE. NE., Sec. 35, was completed July 14, 1939. The Pure No. 1 Fraser, SW. NE. SW., Sec. 26, was the second deep test in the Caddo oil field. It was plugged back to 5,414 ft. where it was completed Oct. 21, 1942, in the Tulip Creek sand [Ordovician]. The Hunton group [Silurian-Devonian], Woodford formation [Mississippian], and the Goddard sand [Mississippian], are the zones which are now producing.

The Caddo anticline as preserved in the surface strata is an extremely sharp fold involving a structural height of at least 5,000 ft. Dips of the strata average more than 60° but range through vertical to overturned. The sandstones of the Springer and Dornick Hills groups [Pennsylvanian], encircle the anticline. It has been proved by drilling that the closure on the anticline is at least 3,000 ft. and that there is also a tremendous decrease in sharpness of folding downward in the competent earlier Paleozoic section. This solid base was also greatly deformed in this region in the Arbuckle orogeny which produced the Caddo fold, but the folding of the competent was mild compared to that of the overlying 7,500 ft. of soft shale containing only thin rigid layers at widespread intervals.

All faulting in the field that has been determined consists of transverse normal faults. Faulting probably took place as the anticline was formed during the Arbuckle mountain orogeny. Evidently the faults are present in the competent pre-Goddard strata but die out in the Goddard shale.--C. E. Branham.

2-2159. Wilshire, L. M. **VALLEY-GROVE (SOUTH-EAST) FIELD, OKFUSKEE COUNTY, OKLAHOMA:** Shale Shaker, v. 10, no. 7, p. 16-18, map, sec., table, March 1960.

The Valley Grove (SE.) field is in northwestern Okfuskee County and includes producing wells in sections 1 and 12 of T. 12 N., R. 8 E. Subsurface studies led to a recommendation for seismic work which pinpointed the structure. The first producer in the field was dry in the Second Wilcox sand [Ordovician], showed gas with a spray of salt water from the Hunton lime [Silurian-Devonian], and produced oil from a sand member of the Gilcrease [Pennsylvanian] zone. At present the Booch [Pennsylvanian], Gilcrease, and Cromwell sand [Pennsylvanian], Hunton lime, and the Wilcox sands are producing in the field. The Valley Grove field is producing from a closure against 2 NE.-SW.-trending faults. The 2 faults outline a narrow graben to the E.--C. E. Branham.

2-2160. Wilgus, A. Curtis, ed. **THE CARIBBEAN: NATURAL RESOURCES**: 315 p., maps, graphs, tables, Gainesville, University of Florida Press, 1959, refs.

Contains papers delivered at the ninth conference on the Caribbean, held at the University of Florida, Dec. 4, 5, and 6, 1958. The 7 parts deal with agricultural resources, mineral resources, water resources, human resources, exploitation of resources (financing development), national and international considerations, and bibliographical sources. The section on mineral resources contains the following papers:

- Arthur, Linden B. Significance of Petroleum in the Caribbean, p. 73-77.
- Morgan, Cecil. The Caribbean and Its Petroleum, p. 78-95.
- Anderson, C. C. Petroleum and Natural Gas in the Caribbean, p. 96-119.
- Mote, Richard H. The Outlook for Caribbean Minerals, p. 120-129.
- Voskuil, W. H. Mineral Resources and Industries of the Caribbean area, p. 130-142.

2-2161. Antropov, P. **WHERE IS 'BIG OIL' TO BE SOUGHT?** Translated by Current Digest of the Soviet Press: Internat. Geology Rev., v. 2, no. 4, p. 351-353, Apr. 1960.

In order to meet a planned increase in annual oil production to 240 million tons and gas to 150 billion cu. m., oil and gas exploration in the U.S.S.R. must be greatly expanded.

The former Minister of the Oil Industry is criticized for neglecting this phase. Finds and prospects in central Asia, Kazakhstan, the northern pre-Caucasus, Siberia, and the Far East are reviewed. --M. Russell.

2-2162. Pierron, E.D., and O.W. Rees. **SOLVENT EXTRACT AND THE PLASTIC PROPERTIES OF COAL**: Illinois State Geol. Survey, Circ. 288, 11 p., 4 graphs, 5 tables, 1960, 4 refs.

The amount of material extractable from coal by certain solvents is related to the maximum fluidity of the coal as measured by the Gieseler plastometer, according to earlier work by Pierron, Rees, and Clark. This relationship has now been further studied for additional coals of different ranks and levels of fluidity. In addition some attention has been given to recombining extracts with residues in different proportions and determining Gieseler fluidities of these blends. Data are presented in this report showing that, for the coals studied, yields of extracts are proportional to maximum fluidities although not necessarily directly proportional. Further data presented indicate that return of extracts to inert residues restores fluidity beyond that of the original coal. --Auth.

2-2163. Zubovic, Peter. **MINOR ELEMENT CONTENT OF COAL FROM ILLINOIS BEDS 5 AND 6 AND THEIR CORRELATIVES IN INDIANA AND WESTERN KENTUCKY**: U.S. Geol. Survey, Repts., Open-File Ser., [no. 537], 79 p., 23 figs. incl. 16 maps, chart, 5 tables, [1960], 25 refs.

Spectrographic analyses for 15 elements of 249 block samples of coal are reported here. These samples represent 28 localities of beds 5 and 6 of

Illinois and their correlatives in Indiana and western Kentucky.

Comparison with the coals of the northern Great Plains province shows a similarity in the total amount of these elements in the coal; however, individual elements differ considerably. The degree of association with the organic or inorganic matter of coal is determined by the separation of 13 samples into float and sink fractions. Be, B, Ti, V, Ga, and Ge are essentially associated with the organic matter of coal. Zn, Sn, and La are invariably found to be associated with the inorganic matter. Cr, Co, Ni, Cu, Mo, and Y have intermediate degrees of association.

The vertical and areal distribution of these elements within a bed is dependent upon the availability of the elements to the accumulation processes of the swamp at the time of deposition. In turn, the availability of these elements is dependent upon the types of source rocks being weathered, the type of weathering, and the method of transport to the depositional site. Further control on the availability of the elements is exercised by the position of the sample. If the sample is near the peripheral areas of the depositional sites, the processes mentioned above control the availability. In the interior portions of the basin, the distribution of these elements is controlled by the amount left in solution after passing through the peripheral areas.--Auth.

2-2164. Guernsey, Lee. **OUTLOOK FOR COAL IN THE UNITED STATES**: Focus, v. 10, no. 3, 6 p., 3 maps, table, Nov. 1959, 6 refs.

A brief historical summary of the use of coal in the United States is followed by a breakdown of the amount and location of known reserves of coal. The estimated world coal reserves are 5.2 trillion tons. Central and South America and much of Africa lack large reserves. Small-scale maps and tables show location of coal deposits and coal production by country for world figures, by state for the United States. The U.S.S.R. led the world in production in 1958; development in that country is summarized. New machines for mining coal are described. Two outstanding uses for coal are in the steel industry and in the production of electricity.--M. Russell.

2-2165. Brant, Russell A., and Edward Q. Moulton. **ACID MINE DRAINAGE MANUAL**: Ohio State Univ., Eng. Expt. Sta., Bull. no. 179, 40 p. 34 figs. Jan. 1960.

Acid water issues from many mines and other openings in coal-mining localities of Ohio. Coal beds are found in the Pennsylvanian and Permian systems, and mining has occurred in at least 23 of the beds. A composite vertical sequence of rocks found in the coal-to-coal intervals is: coal, roof shale, limestone, massive shale, sandstone, sandy shale, clay shale or calcareous shale, fresh-water limestone, underclay, and coal.

Marcasite or pyrite and possibly organically combined S in the coal-bearing rocks are oxidized to iron sulfate and, eventually, to sulfuric acid. Bacteria are probable contributors to oxidation of pyrite materials. The oxidation includes both oxidation of the ferrous and the sulfide ions. Soluble sulfate minerals are also found associated with the coal, shales, and sometimes other rock types, and the mine water itself. Such minerals are melanterite, copiapite, and particularly minerals of the halotrichite-pickeringite group.

Water, which is the transporting agent, may enter through porous rock, joints, faults, or roof-lapse channels, and exit through various openings, usually portals of drift mines. Older abandoned drift mines in Ohio appear to be the principal source of acid mine water. Other sources are gob piles and old mines.

Segregation of the causative agents, water, pyritic material, and O₂, is the effective means of elimination of the acid-forming reaction. The sealing of mines has been attempted in reduction of acid, and the use

of hydrostatic seals is recommended where they may be applied. Burial or flooding of waste pyritic materials effectively reduces the reaction rate. Flow-control measures may have application in some areas. Neutralization is practical only on a very small scale or for special situations. The general approach to the elimination and prevention of acid mine water is to: 1) minimize or prevent acid formation; 2) minimize or prevent entry of acid, if formed, to the stream system; 3) treat the water, if acid has entered the stream system.--Auth.

14. ENGINEERING GEOLOGY

2166. Burke, H.D., A.W. Krumbach, Jr., and G. Rush. LABORATORY TESTS OF LIQUID NITROGEN SOIL-MOISTURE SAMPLERS; U.S. Waterways Expt. Sta., Misc. Paper no. 4-371, 20 p., 1960, tables, Jan. 1960.

This limited laboratory study was made to determine whether a method for quick-freezing and extracting soil samples provided more accurate determination of moisture content than did mechanical samplers, particularly for very wet soils. The quick-freezing was accomplished with liquid N poured into a hollow probe inserted in the soil. In tests on soils whose moisture contents ranged to well above the liquid limit, it was determined that accuracy of the quick-freeze method was almost as good as that of the mechanical samplers. This conclusion was based mainly on reproducibility of results. The liquid N probe was used over a range of soil-moisture contents, the sampling of which normally requires use of 3 types of mechanical samplers.--Auth.

2167. U.S. Federal Housing Administration, Architectural Standards Division, comp. & ed. ENGINEERING SOIL CLASSIFICATION FOR RESIDENTIAL DEVELOPMENTS: 107 p., chart, profile, 6 tables, Dec. 1959, refs.

This manual is intended to provide uniformity in procedures used by FHA (Federal Housing Administration) engineers in evaluating, testing and reporting on soils. Sec. 1, Engineering Soil Classification for Residential Developments, reviews the Unified Soil Classification System, in use by the U.S. Corps of Engineers and U.S. Bureau of Reclamation, and urges its adoption for FHA purposes. The basic concepts of the Unified System are amplified and related to determination of suitability of soils for residential building sites, with their accompanying problems of foundations, streets, sewage disposal, and slope stability. Characteristics and properties of disturbed and undisturbed soils are discussed in terms of site problems and of the limitations inherent in any classification scheme. Two appendices contain helpful information on field identification of soils and methods for determining and reporting consistency and relative density of soils. A third appendix is a glossary of soil mechanics and pedologic terms. In sec. 2, Engineering Soil Test Data for some Agricultural Soil Types, a brief introduction summarizes the concepts and nomenclature used in agricultural soil surveys. The remainder is a list of nearly 400 well-established soils from various parts of the United States, as sampled by U.S. Soil Conservation Service and tested by U.S. Bureau of Public Roads. Multiple samples from different localities are recorded for many soils, and for most of

them the properties of A, B, and C horizons are given separately. Parent material, position below ground surface, maximum dry density, optimum moisture, mechanical analysis, liquid limit, plasticity index, and both A.A.S.H.O. and Unified soil classifications are recorded. The tabulation of test data provide a practical method for geologist or engineer to utilize existing agricultural soil survey information.--E.B. Eckel.

2-2168. Thompson, Thomas L., and John B. Misz. GEOLOGIC STUDIES OF UNDERGROUND NUCLEAR EXPLOSIONS RAINIER AND NEPTUNE, FINAL REPORT: California, Univ., Radiation Lab., [Pub.] UCRL-5757, 58 p., 26 illus., map, 2 plans, 5 secs., Oct. 1959, 16 refs.

The rock changes and displacements resulting from underground nuclear explosions Neptune and Rainier at the Nevada Test Site are analysed. Detonation effects are related to the rock types and structures involved. Gross displacements and fracturing are in accord with the Mohr theory of rupture stress orientation and are the result of primary (blast) and secondary (gravity) induced stresses. The 90-ton Neptune explosion disaggregated and displaced rock material as much as 100 ft. from ground zero. Primary fracturing extended to as far as 145 ft. from ground zero. The 1,700-ton Rainier explosion formed a fused-rock-lined cavity averaging 62 ft. in radius below ground zero and an undetermined radius above. Displacement and disaggregation extended radially to 130 ft. from ground zero and primary fracturing to 150 ft. Hard brittle welded tuff transmitted rupture stresses much greater distances than did "punky" granular tuff.

A collapsed-rock zone was formed 388 ft. upward from ground zero and is postulated to have a domed top. It is concluded that underground nuclear explosions could be applied to mining by block-caving methods, and that material within the crushed zone should be mineable without the use of additional explosives.--M. Russell.

2-2169. Wilmarth, Verl R. SOME EFFECTS OF UNDERGROUND NUCLEAR EXPLOSIONS ON TUFF; U.S. Geol. Survey, Trace Elements Inv. Rept. 756, 34 p., 17 figs., 2 tables, Dec. 1959, 3 refs.

The effects of the Rainier (1.7 kt. at a scaled depth of 690 ft.), Logan (5 at 482), and Blanca (19 at 319) explosions on tuff were determined from observations and measurements on the surface and in drill holes and tunnels.

Rock slides above the explosion points were the most obvious surface effects. Movement took place mainly along preexplosion fractures. Displacements

were observed at distances up to 3,000 ft. on the surface and up to 2,500 ft. in tunnels.

Below the Rainier chamber a hemispherical breccia zone about 75 ft. in radius was found. The breccia contains angular blocks of tuff in a pulverized matrix which contains droplets and fragments of radioactive glass. The glass contains the bulk of the fission products and seems to be restricted to the breccia zone. Beyond the breccia for a radial distance of at least 110 ft. from the chamber, the tuff is minutely fractured and is characterized by low compressive strength, low velocity, and high permeability. One year after the explosion, temperatures greater than 2°C. above normal extended 120 ft. horizontally and 80 ft. vertically from the chamber. Integration of anomalous temperature data indicates that over half the energy in the explosion was in the form of heat. The temperatures probably dropped below the boiling point of water a few hours or days after the explosion because of the rapid transfer of heat by steam through explosion-produced and natural fractures.--Auth.

2-2170. Hvorslev, Mikael Juul, and T.B. Goode. CORE DRILLING IN FROZEN GROUND: U.S. Waterways Expt. Sta., Tech. Rept. no. 3-534, 32 p., tables, Jan. 1960.

The problem of foundation exploration in arctic and subarctic regions is reviewed briefly, and the methods used and results obtained in the drilling and coring phases of a core boring program conducted in Greenland in 1956 and 1957 are described. Cores of hard-frozen glacial till containing cobbles and boulders and cores of glacier ice were obtained with double-tube, swivel-head core barrels using bottom-discharge diamond bits in glacial till and special steel saw-toothed bits in glacier ice. Diesel oil or water at temperature of 23-33°F. was used as the drilling fluid and was cooled as required by addition of snow or ice and common salt. A truck-mounted rotary drill rig was used in all drilling operations. It was demonstrated that satisfactory cores of coarse glacial till and glacier ice can be obtained by means of the equipment and methods used. Sufficient experience was acquired to justify tentative recommendations regarding bit speed and pressure and rate of drilling fluid circulation.--Auth.

2-2171. Kachadoorian, Reuben, and others. GEOLOGIC INVESTIGATIONS IN SUPPORT OF PROJECT CHARIOT IN THE VICINITY OF CAPE THOMPSON, NORTHWESTERN ALASKA - PRELIMINARY REPORT: U.S. Geol. Survey, Trace Elements Inv. Rept. 753, 94 p., 13 figs. incl. maps, graphs, 3 pls. (in pocket) incl. 2 geol. maps, secs., 14 tables (2 in pocket), Jan. 1960, refs.

The Chariot test site at Ogotoruk Creek is topographically well situated for the construction of an experimental deep-water excavation as proposed by the U.S. Atomic Energy Commission.

The rocks of the area consist entirely of consolidated clastic and chemical sediments of marine and brackish water depositional environments. They include sandstone, calcitic and dolomitic limestone, chert, argillite, mudstone, siltstone, and graywacke. All the rocks have been highly deformed and very slightly metamorphosed. The rocks range in age from Early Mississippian to Jurassic(?) and Cretaceous.

The material to be excavated consists chiefly of

mudstone, siltstone, and sandstone of the Tiglukpak formation of Jurassic(?) age. Test holes Able and Baker indicate that the devices will be located entirely in frozen mudstone containing numerous small faults. The fault zones in the mudstone are generally less than 1 ft. thick. In Hole Baker, however, there is a 14.1-ft. fault zone from 136.2 ft. to 150.3 ft. below the surface. Locally, the mudstone is so highly fractured that it occurs as splinters 1/8- to 1/4-in. thick, 1/2- to 1-in. wide, and about 3 in. long.

During the drilling program in 1959 the walls of the holes slumped into the bottom of the hole when the relatively warm drilling fluid thawed the permafrost in the mudstone. Slumping of debris into the hole will be one of the major problems during the construction of the device holes if proper techniques are not utilized. The greatest amount of slumping will take place in the fault zones and the unconsolidated materials that overlie the mudstone if they are allowed to thaw.

The moisture content of the rocks in place probably is much higher than that reported by the Corps of Engineers for samples of the rock. The reported moisture content (0.28 to 5.67%) was based on thawed core sent to the Corps of Engineers laboratory in Anchorage, Alaska, and no consideration could be given to the fact that the rocks are perennially frozen and that some of the fracture zones may contain ice. It is believed that the moisture content is in the vicinity of 10% in the rocks that underlie the test site.

On the basis of preliminary geothermal data the tentative depth of permafrost in Hole Able is at least 800 ft. below the surface and at least 1,000 ft. in Hole Baker. The absence of reliable data concerning the lower half of Hole Baker makes it difficult to determine the undisturbed geothermal gradient below the zone of climatic change.

Seismic measurements in the frozen Tiglukpak rocks indicate velocities ranging from 11,500 to 14,500 f.p.s. and averaging about 13,500 f.p.s. Surface refraction measurements suggest a slight increase of velocity with depth, but this increase with depth is not supported by the in-hole velocity logs. The drilling program planned for the summer of 1959 could not be completed, so that seismic velocities in the unfrozen mudstones beneath the permafrost could not be measured; therefore an attempt was made to measure by seismic refraction the depth to the high-velocity chert and limestone that is believed to underlie the Tiglukpak. However, this refraction work had not been planned previously, and neither sufficient equipment nor time were available to obtain satisfactory results. Although a higher velocity was measured near the N. end of a 7,500-ft. profile, there is considerable doubt whether this higher velocity represents a deep refractor. If the high velocity does represent a deep refractor, its depth is somewhere between 1,000 and 1,750 ft.

The beach at the Chariot site is in a steady-state condition and is not advancing toward the land at a rate that is significant from an engineer's standpoint. Erosion behind the beach may be in the order of 1 or 2 ft. a century. The net alongshore transport of sediments is approximately 5 cu. yds. an hour to the SE. during the ice-free periods. However, during heavy storms the beach transport of sediments may be more than 1,000 cu. yds. per hour. Therefore, jetties should be constructed on each of the excavated channels to accommodate the volume of material that may be moved during these storms.

Shallow and deep aquifers exist in the test site area. The shallow aquifers consist principally of unconsolidated material dependent upon recharge from

surface sources during the summer. The deep aquifers are in permeable portions of bedrock and receive recharge water from distant sources. Both types of aquifers may be contaminated by any radioactive fallout from the proposed nuclear test. The shallow aquifers would receive contaminated surface water immediately, whereas it may take years for the deep aquifers to receive the contaminated surface water. On the basis of data available, the suspended sediment discharge of Ogotoruk Creek can be considered minor compared to the size of the proposed excavation. The chemical composition of the waters indicates springs as well as surface water exist in the vicinity of the test site. The radiochemical levels of the fresh waters are low and in the same magnitude as are normally found. The highest beta activity of the fresh waters was found in the 2 ponds approximately 6 mi. N. of the test site, and might be ascribed to fallout which has accumulated from previous detonations and which has not been flushed out owing to lack of natural drainage. The chemical composition of the water of the larger control pond to the E. is unusual for the area, in that it has a high mineral content.

For all practical purposes, no flow occurred in Ogotoruk Creek from Oct. 1, 1958, to late in May 1959. There may have been some flow on certain scattered days, but amounts were too small to be considered of any importance in the over-all surface-water study. No definite conclusions can be drawn from the limited stream-flow records obtained thus far, except that little flow is likely between mid-Oct. and mid-May.--Auth.

2-2172. Currier, L.W. THE SEISMIC METHOD IN SUBSURFACE EXPLORATION OF HIGHWAY AND FOUNDATION SITES IN MASSACHUSETTS: U.S. Geol. Survey, Circ. 426, 8 p., 5 figs., 1960.

Coordinated geologic mapping and subsurface exploration answer some of the questions faced by contractors in highway construction. Thickness of various soil materials and the position of buried bedrock are investigated by wash borings, core drilling, and geophysical exploration. The procedure found most useful in Massachusetts is the refraction seismic method.--U.S. Geol. Survey.

15. MISCELLANEOUS

2-2173. Jastrow, Robert. THE EXPLORATION OF THE MOON: Sci. American, v. 202, no. 5, p. 69, 7 illus., May 1960.

The moon will be the first and possibly the most important extraterrestrial body to be explored. Its importance lies in its essentially pristine surface, uneroded, and covered with cosmic dust recording billion years of the solar system's history.

A major objective of exploration of the moon will be to determine its temperature history and shed light on the "collision" vs. "dust cloud" theories of evolution of the solar system. The investigations to the precise size of the moon's equatorial bulge have already given evidence of its cold past.

Lunar satellites will measure density distributions, chemical and physical characteristics, etc., perhaps solving the old argument over volcanic vs. impact origin of the moon's "craters." Present arguments favor an impact origin.

Investigations have begun on solar proton bombardment to explain the less than 10-cm. average irregularity revealed by recent radio telescopic techniques. Sophisticated satellite photography or TV may be able to delineate details smaller than the 1000-ft. minimum now visible through the best telescopes. Instruments to be landed on the moon include: a gamma ray spectrometer, seismometer, gravimeter, X-ray fluorescence spectrometer, ionosphere and plasma probes, density gauges, magnetometer, TV camera, and finally a self-propelled instrument platform in preparation for the ultimate and most rewarding lunar exploration phase - man's landing.--R.F. McAllister.

2-2174. Arctic Institute of North America. ARCTIC BIBLIOGRAPHY, VOL. VIII. Edited by Marie Perle. 1281 p., map, U.S. Dept. of Defense, 1959.

Continuation of this annotated bibliography of scientific literature on the arctic and subarctic regions of the world. This volume contains 5,623 references, mainly to material published during 1950-

1956, including publications on geology and related sciences.

2-2175. Alabama, Geological Survey, and Alabama, State Oil and Gas Board. ANNUAL REPORTS FOR THE FISCAL YEAR OCTOBER 1, 1958 - SEPTEMBER 30, 1959, by Walter B. Jones: 46 p., 4 maps, 2 graphs, tables, University, 1960.

2-2176. Florida Geological Survey. THIRTEENTH ANNUAL REPORT, COVERING PERIOD JANUARY 1, 1957 THROUGH DECEMBER 31, 1958: 84 p., 3 illus., 7 maps (2 col.), graph, 4 tables, Tallahassee, 1959.

2-2177. Lord, C.S. FIELD WORK, 1959: Canada, Geol. Survey, Inf. Circ. no. 3, 40 p., Jan. 1960, 55 refs.

The report describes briefly, by provinces, field projects undertaken by the Geological Survey of Canada during 1959, indicates progress made, and summarizes some of the results. Geologic features or mineral occurrences that might be of immediate or direct economic interest are given.--M. Russell.

2-2178. Kropotkin, P.N. SUCCESSES IN GEOLOGY IN CHINA. Prepared by U.S. Joint Publications Research Service: Internat. Geology Rev., v. 2, no. 4, p. 357-360, Apr. 1960.

The status of geology in China is summarized. The number of geologists is now several thousand, and many more are in training at newly established universities. A general statement of the structural and stratigraphic components of China relates the principal ore deposits to igneous and tectonic activity. Recent geologic studies of note by Chinese geologists include new geologic mapping, oil and coal investigations, discoveries in paleontology and paleobotany, regional and theoretical studies in tectonics, petrography, geophysics, and geochemistry. New discoveries of Fe and Cu have been made, and increased production of coal, oil, mineral fertilizers,

and construction materials accomplished.--M. Russell.

2-2179. Lisitzin, A.P., and A.V. Zhivago. MARINE GEOLOGICAL WORK OF THE SOVIET ANT-ARCTIC EXPEDITION, 1955-1957: Deep-Sea Research, v. 6, no. 2, p. 77-87, illus., 2 charts, 4 graphs, Feb. 1960, 12 refs.

In accordance with plans for the International Geophysical Year, the Marine Antarctic Expedition of the U.S.S.R. Academy of Sciences began oceanographic work, especially work in submarine geology, in 1955 in the Antarctic and in the Indian Ocean. Echo soundings in South Polar seas were taken over tens of thousands of miles, particularly in little known areas, and new submarine elevations were found in an extensive area of recent volcanic activity W. of the submarine mountain range extending between Kerguelen and Gaussberg. For the first time in Antarctic waters, cores up to 16 m. long were obtained, and samples of bottom sediments were collected on the 2 voyages at more than 200 stations. A systematic study was made of the distribution and composition of particles suspended in sea water, as well as the seismo-acoustic work on the thickness of the unconsolidated sediments on the ocean bottom. The expedition is at present continuing work in the Indian and Pacific Ocean.--Auth.

2-2180. Sochava, V.B. GEOBOTANICAL MAP OF THE U.S.S.R. Translated by Marcella Woerheide: Internat. Geology Rev., v. 2, no. 4, p. 311-321, 2 illus., Apr. 1960.

A newly compiled geobotanical map of the U.S.S.R., scale 1:4,000,000 is described. Two hundred and ten categories of vegetation are mapped, classified under 15 major groups. The relation of the mapped vegetation units to climate, soil, ground condition (permafrost), watersheds, and major geomorphic features is emphasized.--M. Russell.

2-2181. Kinoshita, Willie T., and Bion H. Kent. PHOTOGRAMMETRIC DETERMINATION OF ELEVATIONS FOR REGIONAL GRAVITY SURVEYS: Geophysics, v. 25, no. 2, p. 445-450, graph, Apr. 1960, 2 refs.

Precision photogrammetric methods were used to obtain elevations of gravity stations in an area in the southern Sierra Nevada and in W.-central Idaho. In both areas, relief is more than 3,000 ft., and in the

Idaho area there is also a dense cover of forest and brush.

In addition to photogrammetric determinations of gravity station elevations in the Idaho area, 55 photogrammetric elevations were determined for ground points that had been established previously by topographic surveys. A statistical analysis of the differences between photogrammetric and known ground elevations indicated that the mean of the errors is -0.2 ft.; 71% of the photogrammetric errors are included within one standard deviation (3.4 ft.), and 96% of the errors are included within twice the standard deviation (6.8 ft.).

The photogrammetric combination used in both areas was the multiplex stereoscopic plotting instrument and 1:49,500 scale photography taken with a 6-in. focal length lens. It is probable that smaller standard deviations can be obtained by combining larger scale photography with more precise stereoscopic plotting instruments.--Auth.

2-2182. American Museum of Natural History. THE LERNER MARINE LABORATORY AT BIMINI, BAHAMAS: 52 p., 21 illus., New York, [1960].

A general description of the physical plant and research facilities of the Lerner Marine Laboratory, a field station of the American Museum of Natural History, located on North Bimini Island, Bahamas. The laboratory was established in 1948 as a research station, primarily in the field of marine biology. Of interest to geologists are the facilities available for study in ecology and the formation of reef limestone.--M. Russell.

2-2183. Bowen, Boone M., Jr., J. M. Selby, and James Hubert Edgerton. GEOLOGY AND HYDROLOGY IN THE DISPOSAL OF RADIOACTIVE WASTES: Georgia Acad. Sci., Bull., v. 17, no. 4, p. 145-152, Sept. 1959, 14 refs.

The problems of radioactive waste disposal and the talents needed to solve them are varied. Solid, liquid, and gaseous wastes must be handled in different ways. Many of the methods are in the realm of the earth sciences. Ground disposal of solid as well as low- and intermediate-level liquid wastes is an efficient, safe, and economical method when effected under carefully controlled conditions. Geological and hydrological parameters are of utmost importance in this method. Other means of radioactive waste disposal of concern to geologists are being investigated, and more research and development need to be done on these projects.--Auth.

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